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UNION CARBIDE

ENVIRONMENTAL MONITORING REPORT

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE FACILITIES

Calendar Year 1979

APPROVAL FOR RELEASE

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ENVIRONMENTAL MONITORING REPORT

UNITED STATES DEPARTMENT OF ENERGY

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Calendar Year 1979

UNION CARBIDE CORPORATION – NUCLEAR DIVISION

Oak Ridge Gaseous Diffusion Plant

Oak Ridge National Laboratory

Oak Ridge Y-12 Plant

Office of Health, Safety, and Environmental Affairs

Post Office Box Y

Oak Ridge, Tennessee 37830

TABLE OF CONTENTS

PAGE

INTRODUCTION 1

SUMMARY 3

MONITORING DATA – COLLECTION, ANALYSIS, AND EVALUATION

- Air Monitoring 5
- External Gamma Radiation Monitoring 9
- Water Monitoring 9
- Biological Monitoring 14
- Soil and Sediment Monitoring 18
- Calculation of Potential Radiation Dose to the Public 18

REFERENCES 59

APPENDIX A 62

LIST OF FIGURES

FIGURE		PAGE
1	Air, Vegetation, and Soil Sampling Locations	6
2	Remote Air Monitoring Locations	7
3	Stream Monitoring Locations	11
4	Curies Discharged Over White Oak Dam	12
5	Percentage Concentration Guide Levels in The Clinch River	13
6	Immediate Environs Milk Sampling Locations	15
7	Remote Environs Milk Sampling Locations	16
8	Oak Ridge Gaseous Diffusion Plant Sediment Sampling Locations	19
9	Meteorological Data for the Oak Ridge Reservation	21
10	Exposure Pathways	22
A1	Flow Chart of QA Program	63

LIST OF TABLES

TABLE		PAGE
1	Incremental Population Table In The Vicinity of ORNL	25
2	Continuous Air Monitoring Data (Gross Beta Activity)	26
3	Continuous Air Monitoring Data (Gross Alpha Activity)	27
4	Continuous Air Monitoring Data (Specific Radionuclides)	28
5	Concentration of ^{131}I in Air as Measured by the Perimeter Air Monitoring Stations	29
6	Discharges of Radioactivity to the Atmosphere	30
7	Air Monitoring Data – Fluorides	31
8	Air Monitoring Data – Suspended Particulates	32
9	External Gamma Radiation Measurements	33
10	Radionuclides in the Clinch River	34
11	Uranium Concentration in Surface Streams	35
12	Discharges of Radioactivity to Surface Streams	36
13	Long-Lived Gross Beta Activity in Rainwater	37
14	Chemical Water Quality Data – White Oak Dam	38
15	Chemical Water Quality Data – Melton Hill Dam	39
16	Chemical Water Quality Data – ORGDP Sanitary Water Pumping Station	40
17	Chemical Water Quality Data – ORGDP Recirculating Water Pumping Station	41
18	Chemical Water Quality Data – Clinch River Downstream of ORGDP	42
19	Chemical Water Quality Data – East Fork Poplar Creek	43
20	Chemical Water Quality Data – Bear Creek	44
21	Chemical Water Quality Data – Poplar Creek Above Blair Bridge	45
22	Chemical Water Quality Data – Poplar Creek Near Clinch River	46

TABLE (contd.) PAGE

23 National Pollutant Discharge Elimination System (NPDES) Experience 47
24 Concentration of ^{131}I in Milk 50
25 Concentration of ^{90}Sr in Milk 51
26 Radionuclide Content of Clinch River Fish 52
27 ^{137}Cs Concentrations in Deer Samples 53
28 Vegetation Sampling Data 54
29 Radioactivity in Grass Samples From Perimeter and Remote Monitoring Stations 55
30 Radioactivity In Soil Samples from Perimeter and Remote Air Monitoring Stations 56
31 Stream Sediment Samples 57
32 Summary of the Estimated Radiation Dose 58

INTRODUCTION

Oak Ridge is located in East Tennessee in a broad valley which lies between the Cumberland Mountains on the northwest and the Great Smoky Mountains on the southeast. The Department of Energy (DOE) Reservation is located in the Valley and Ridge physiographic province which is characterized by parallel ridges of sandstone, shale, and cherty dolomite, separated by valleys of less weather-resistant limestone and shale. The ridges are oriented southwest-northeast. Topography of the area is due to differential erosion of severely folded and faulted rocks ranging in age from Early Cambrian to Early Mississippian. Elevations range from 226 meters to 415 meters above mean sea level with a maximum relief of 189 meters. The area includes gently sloping valleys and rolling to steep slopes and ridges. The Tennessee Valley Authority's (TVA) Melton Hill and Watts Bar Reservoirs on the Clinch River form the southern and western boundaries of the Reservation while the City of Oak Ridge (approximately 28,000 population) is on the northern boundary.

The local climate is noticeably influenced by topography. Prevailing winds are usually either up-valley, from west to southwest, or down-valley, from east to northeast. During periods of light winds, daytime winds are usually southwesterly and nighttime winds usually northeasterly. Wind velocities are somewhat decreased by the mountains and ridges, and tornadoes rarely occur. In winter, the Cumberland Mountains have a moderating influence on the local climate by retarding the flow of cold air from the north and west. Temperatures of 38°C or higher and-18°C or below are unusual. Low-level temperature inversions occur during approximately 56 percent of the hourly observations. Winter and early spring are the seasons of heaviest precipitation with the monthly maximum normally occuring during January to March. The mean annual precipitation is approximately 137 centimeters.

The topography of the Oak Ridge Area is such that all drainage from the DOE Reservation flows into the Clinch River which has its headwaters in southwestern Virginia and flows southwest to its mouth near Kingston, Tennessee. The Clinch River flow is regulated by several dams which provide reservoirs for flood control, electric power generation, and recreation. The principal tributaries through which liquid effluents from the plant areas reach the Clinch River are White Oak Creek, East Fork Poplar Creek, and Poplar Creek.

With the exception of the City of Oak Ridge, the land within 8 kilometers of the DOE Reservation is predominantly rural being utilized largely for residences, small farms,and pasturage for cattle. The approximate location and population of the towns nearest the DOE Reservation are: Oliver Springs (pop. 3400) 11 kilometers to the northwest; Clinton (pop. 4800) 16 kilometers to the northeast; Lenior City (pop. 5300) 11 kilometers to the southeast; Kingston (pop. 4100) 11 kilometers to the southwest; and Harriman (pop. 8700) 13 kilometers to the west. Knoxville, the major metropolitan area nearest Oak Ridge, is located about 40 kilometers to the east and has a population of approximately 175,000. A directional 80-kilometer population distribution, which is used for population dose calculations later in this report, is shown in Table 1.

The DOE Reservation contains three major operating facilities: the Oak Ridge National Laboratory (ORNL), the Oak Ridge Gaseous Diffusion Plant (ORGDP), and the Y-12 Plant; all of which are operated by Union Carbide Corporation, Nuclear Division. In addition, two smaller DOE facilities are in the area: the Comparative Animal Research Laboratory, and the Oak Ridge Associated Universities.

The Oak Ridge National Laboratory is a large multipurpose research laboratory whose basic mission is the discovery of new knowledge, both basic and applied, in all areas related to energy. To accomplish this mission, the Laboratory conducts research in all fields of modern science and technology. The Laboratory's facilities consist of nuclear reactors, chemical pilot plants, research laboratories, radioisotope production laboratories, and support facilities.

The Oak Ridge Gaseous Diffusion Plant (ORGDP) is a complex of production, research, development, and support facilities located west of the city of Oak Ridge. While the primary function of ORGDP is the enrichment of uranium hexafluoride (UF_6) in the uranium-235 isotope, extensive efforts are also expended on research and development activities associated with both the gaseous diffusion and gas centrifuge processes. In addition, the barrier material used by all three Department of Energy-owned gaseous diffusion plants is manufactured at ORGDP. Numerous other activities (maintenance, nitrogen production, steam production, uranium recovery, fluorine production, water treatment, laboratory analysis, administration, etc.) lend support to these primary functions and are thus essential to the operation of this plant.

The Oak Ridge Y-12 Plant which is located immediately adjacent to the City of Oak Ridge has four major responsibilities: (1) production of nuclear weapon components, (2) fabrication support for weapon design agencies, (3) support for the Oak Ridge National Laboratory, and (4) support and assistance to other government agencies. Activities associated with these functions include the production of lithium compounds, the recovery of enriched uranium from unirradiated scrap material, and the fabrication of uranium and other materials into finished parts and assemblies. Fabrication operations include vacuum casting, arc melting, powder compaction, rolling, forming, heat treating, machining, inspection, and testing.

Operations associated with the DOE research and production facilities in Oak Ridge give rise to several types of waste materials.

Radioactive wastes are generated from nuclear research activities, reactor operations, pilot plant operations involving radioactive materials, isotope separation processes, uranium enrichment, and uranium processing operations. Nonradioactive wastes are generated by normal industrial-type support operations that include water demineralizers, air conditioning, cooling towers, acid disposal, sewage plant operations, and steam plant operations.

Nonradioactive solid wastes are buried in a centralized sanitary landfill or designated burial areas. Radioactive solid wastes are buried in designated burial areas or placed in retrievable storage either above or below ground depending upon the type and quantity of radioactive material present and the economic value involved.

Gaseous wastes generally are treated by filtration, electrostatic precipitation, and/or chemical scrubbing techniques prior to release to the atmosphere. The major gaseous waste streams are released through stacks to provide atmospheric dilution for materials which may remain in the stream following treatment.

Liquid radioactive wastes are not released but are concentrated and contained in tanks for ultimate disposal. Process water which may contain small quantities of radioactive or chemical pollutants is discharged, after treatment, to White Oak Creek, Poplar Creek, East Fork Poplar Creek, and Bear Creek, which are small tributaries to the Clinch River.

SUMMARY

The Environmental Monitoring Program for the Oak Ridge area includes sampling and analysis of air, water from surface streams, creek sediments, biota, and soil for both radioactive and nonradioactive materials. This report presents a summary of the results of the program for calendar year 1979.

Surveillance of radioactivity in the Oak Ridge environs indicates that atmospheric concentrations of radioactivity were not significantly different from other areas in East Tennessee. Concentrations of radioactivity in the Clinch River and in fish collected from the river were less than 3 percent of the permissible concentration and intake guides for individuals in the offsite environment. While some radioactivity was released to the environment from plant operations, the concentrations in all of the media sampled were well below established standards.

The total body dose to a "hypothetical maximum exposed individual" at the site boundary was calculated to be 6.6 millirem/yr which is 1.3 percent of the DOE Manual Chapter 0524 standard. The maximum 50-year dose commitment to the critical organ of an individual from the aquatic food chain was calculated to be 35 millirem to the bone which is 2.3 percent of the allowable annual standard. The maximum dose commitment to individuals living nearest the site boundary from airborne releases, assuming continuous residence, was 0.5 millirem to the total body and 5.1 millirem to the lung. These doses are 0.1 percent and 0.34 percent, respectively, of the annual standards. The average total body dose to an Oak Ridge resident was estimated to be 0.02 millirem as compared to approximately 100 millirem/yr from natural background radiation; the average dose commitment to the lung of an Oak Ridge resident was 0.4 millirem. The cumulative total body dose to the population within an 80-kilometer radius of the Oak Ridge facilities resulting from 1979 effluents was calculated to be 5.3 man-rem. This dose may be compared to an estimated 74,000 man-rem to the same population resulting from natural background radiation.

Surveillance of nonradioactive materials in the Oak Ridge environs shows that established limits were not exceeded for those materials possibly present in the air as a result of plant operations with the exception of suspended particulates and fluorides. Suspended particulate concentrations exceeded the 24-hour ambient standard on one occasion at one monitoring location. Fluoride concentrations exceeded the 7-day averaging interval on one occasion at three monitoring locations which resulted in the 30-day averaging interval being exceeded on one occasion at two of these locations. Regulations allow one excursion per year above the specified limits at each monitoring location.

The chemical water quality data in surface streams obtained from the water sampling program indicated that average concentrations resulting from plant effluents were in compli-

ance with State stream guidelines with the exception of zinc and nitrate nitrogen which equalled or exceeded the guidelines.

National Pollutant Discharge Elimination System (NPDES) permit compliance information has been included in this report.

During 1979, a total of nine spills of oil and/or hazardous materials from the Oak Ridge installations were reported to the National Response Center. One reportable oil spill occurred at ORGDP, seven reportable oil spills occurred at ORNL, and one reportable hazardous material spill which resulted in a fish kill occurred at the Y-12 Plant. The Spill Control and Countermeasure (SPCC) Plans for the installations have been revised and modifications have been made to equipment and operating procedures to reduce the probability of similar spills in the future.

MONITORING DATA COLLECTION, ANALYSIS, AND EVALUATION

Environmental monitoring data for calendar year 1979 are summarized in Table 2 through 32. In general, the data tables show the number of samples collected at each location, the maximum concentration, the minimum concentration, the average concentration, the relevant standard, and percent of standard for the average of each parameter. Averages are usually accompanied by plus-or-minus (±) values which represent the 95 percent confidence limits. The 95 percent confidence limits which are calculated from the standard deviation of the average, assuming a normal frequency distribution, are predictions of the variability in the range of concentrations based on a limited number of measurements. They do not represent the conventional error in the average of repeated measurements on identical samples. Data which are below the minimum detectable limit are expressed as less than (<) the minimum detectable value. In computing average values, sample results below the detection limit are assigned the detection limit value with the resulting average value being expressed as less than (<) the computed value.

Average environmental concentrations are compared with applicable standards where such standards have been established, as a means of evaluating the impact of effluent releases. In some cases, for lack of an official standard, stream concentrations of nonradioactive pollutants have been compared with Tennessee State Health Department stream guidelines.

Liquid effluent monitoring data have been compared to the limits specified in the National Pollutant Discharge Elimination System (NPDES) permits issued to the Oak Ridge Facilities by the Environmental Protection Agency (EPA).

Air Monitoring

Radioactive — Atmospheric concentrations of radioactive materials occuring in the general environment of East Tennessee are monitored by two systems of monitoring stations. One system consists of nine stations (HP-31 through HP-39) which encircle the perimeter of the Oak Ridge area and provides data for evaluating releases from Oak Ridge facilities to the immediate environment, Figure 1. A second system consists of eight stations (HP-51 through HP-58) encircling the Oak Ridge area at distances of from 19 to 121 kilometers, Figure 2. This system provides background data to aid in evaluating local conditions. Sampling for radioactive particulates is carried out by passing air continuously through filter papers. Filter papers are evaluated weekly by gross beta and gross alpha counting techniques and composited by system quarterly for specific radionuclide analysis during normal operations. More frequent detailed analyses are performed if concentrations in the environment are significantly above normal. Airborne radioactive iodine is monitored in the immediate environment (HP-31 through HP-39) by passing air continuously through cartridges containing activated charcoal. Charcoal cartridges are evaluated for radioactive iodine by gamma spectrometry.

Data on the concentrations of radioactive materials in air and the quantities of radioactive materials released to the atmosphere in the Oak Ridge and surrounding areas are given in Tables 2 through 6.

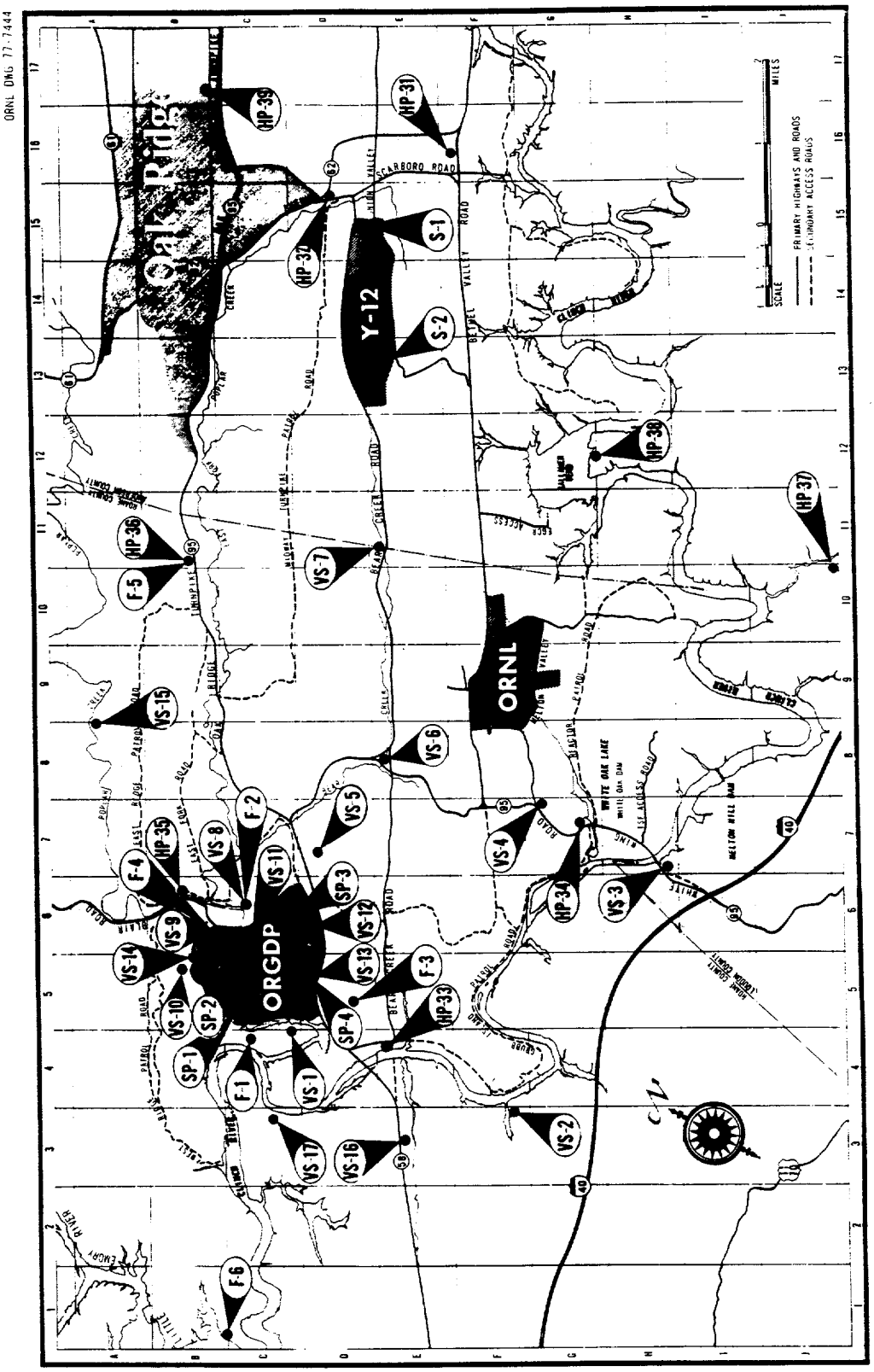

Figure 1
AIR, VEGETATION, AND SOIL SAMPLING LOCATIONS

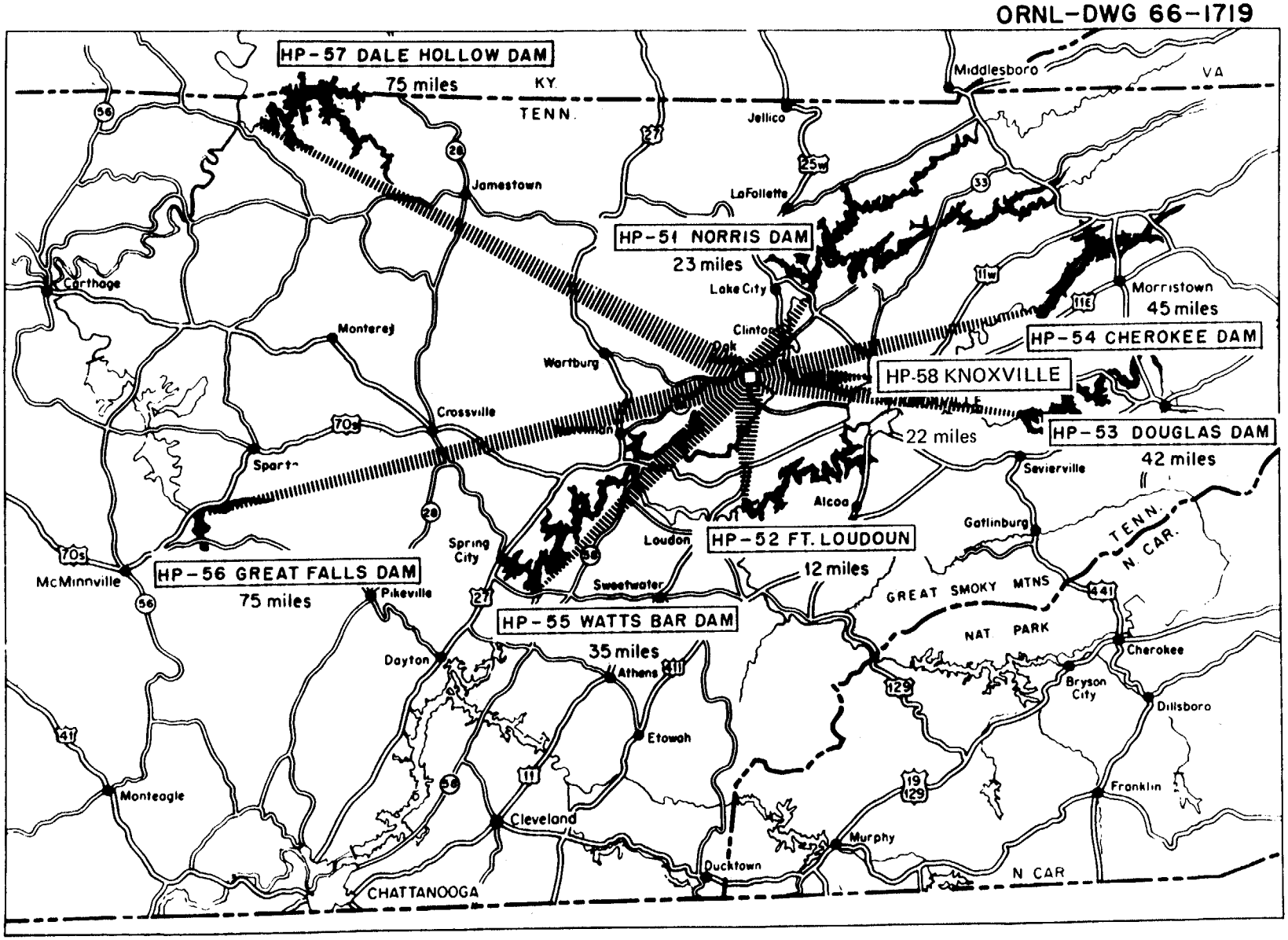

Figure 2

REMOTE AIR MONITORING LOCATIONS

The average gross beta concentrations of radioactivity from particulates in air measured by both the perimeter and remote monitoring systems were 0.03 and 0.02 percent, respectively, of the applicable concentration guide (CG) as specified in the DOE Manual, Appendix 0524[1] for individuals in uncontrolled areas (Table 2).

The average gross alpha concentrations in the perimeter and remote monitoring systems were 0.03 and 0.02 percent, respectively, of the CG for a mixture of uranium isotopes (Table 3).

The results of specific radionuclide analyses of composited filters are given in Table 4. The environmental concentrations tabulated are all at least a thousand times less than the applicable DOE concentration guides for the radionuclides detected.

The concentration of ^{131}I as measured by the perimeter air monitoring system was <0.01 percent of the inhalation concentration guide for individuals in uncontrolled areas (Table 5).

While some radioactivity was released to the atmosphere (Table 6), measurements in the Oak Ridge area show that environmental levels were well below established standards.

Nonradioactive — Environmental air samples are taken for the determination of fluorides, suspended particulates, and sulfur dioxide.

Sampling locations for fluorides are indicated by F-1 through F-6, Figure 1. The current sampling procedure is to obtain seven-day samples collected on potassium carbonate treated paper and to analyze weekly by specific ion electrode. The seven-day analyses are then averaged to obtain 30-day values.

Suspended particulates are measured at locations SP-1 through SP-4, Figure 1. The method for the determination of suspended particulates is the high volume method recommended by EPA. Particulates are collected by drawing air through weighed filter paper. The filter paper is allowed to equilibrate in a humidity controlled atmosphere and the filter is reweighed. From the weight of particulates, the sampling time, and the air flow rate, the particulate concentrating in micrograms per cubic meter is calculated. The sampling period is 24 hours.

The two continuous monitoring stations (S-1 and S-2) in the Y-12 Plant area used for measurement of ambient sulfure dioxide concentrations malfunctioned in the first part of 1979. Due to the unreliability of the equipment, no data were collected until the equipment was replaced with two new type analyzers in November which use the pulsed ultraviolet fluorescence principal of measurement. Each station consists of an analyzer and recorder with associated equipment located in a temperature controlled shelter. Sulfur dioxide concentrations are interpreted on an hourly basis and averaged for 24-hour, monthly, and annual periods. No data on ambient sulfur dioxide concentrations are presented in this report but will be included in the report for next year.

Air monitoring data for fluorides and suspended particulates are presented in Tables 7 and 8. The data indicate that suspended particulate concentrations exceeded the 24-hour ambient standard[2] on one occasion at one monitoring location and fluoride concentrations exceeded the 7-day averaging interval on one occasion at three monitoring locations which resulted in the 30-day averaging interval being exceeded on one occasion at two of these locations. Regulations allow one excursion per year above the specified limits at each monitoring location.

Installation of electrostatic precipitators at the ORGDP steam plant was completed in 1978 and acceptance testing of the precipitators for compliance with emission limits was completed in 1979. All applicable Tennessee standards for particulate emissions from the steam plant stacks were met.

The Y-12 steam plant is being upgraded to operate more efficiently at higher steam load levels. The current electrostatic precipitator installation is not adequate to meet emission limits at higher steam load levels. Funds have been requested for the installation of pollution control equipment to meet emission limits under higher operating load conditions.

External Gamma Radiation Monitoring

External gamma radiation background measurements are made routinely at the perimeter air monitoring stations and at the remote monitoring stations using calcium fluoride thermoluminescent dosimeters suspended one meter above the ground. Dosimeters at the perimeter stations are collected and analyzed monthly. Those at the remote stations are collected and analyzed semiannually.

Data on the average external gamma radiation background are given in Table 9. A considerable variation in background levels is normally experienced in East Tennessee depending upon elevation, topography, and geological character of the surrounding soil.[3]

External gamma radiation measurements were performed along the stream course of East Fork Poplar Creek to evaluate radioactivity which might be contained in the sediments as a result of effluent releases. Additionally, measurements were made along the bank of the Clinch River from the mouth of White Oak Creek several hundred yards downstream to evaluate gamma radiation levels resulting from effluent releases and "sky shine" from an experimental ^{137}Cs plot located near the river bank. Measurements were made using scintillation detectors and/or thermoluminescent dosimeters suspended one meter above the ground surface. The average background level determined at the remote stations was subtracted from the measured gamma radiation levels to determine the incremental increases resulting from plant operations.

Gamma levels long East Fork Poplar Creek ranged from 0 to 10 μR/hr above background. The external gamma radiation levels along the bank of the Clinch River ranged from 5 to 27 μR/hr above background. Potential doses to individuals in the environment from these elevated gamma radiation levels were calculated and are included, where significant, in the dose assessment section of the report.

Water Monitoring

Radioactive — Water samples are collected in the Clinch River for radioactivity analyses at Melton Hill Dam (Station C-2) 3.7 kilometers above White Oak Creek outfall, at the ORGDP sanitary water intake (Station C-3) 10 kilometers downstream from the entry of White Oak Creek, at the ORGDP recirculating water intake (Station C-4) downstream from the Poplar Creek outfall, near Brashear Island (Station C-6), and at Center's Ferry (Station C-5) near Kingston, Tennessee, Figure 3. Samples are collected continuously at all locations except for Station C-5 and Station C-6 which are collected on a daily and monthly grab-sample basis, respectively. Samples are composited for monthly or quarterly analysis depending upon location.

Water samples also are collected for radioactivity analyses at White Oak Dam (Station W-1), at the outlet of New Hope Pond on East Fork Poplar Creek (Station E-1), in Bear Creek (Station B-1), and in Poplar Creek (Stations P-1 and P-2), Figure 3. The samples collected at Stations W-1, E-1, and B-1 are continuous proportional samples. Twenty-four hour composite samples are collected at Stations P-1 and P-2 on a weekly basis. Water samples were collected also at the juncture of White Oak Creek and the Clinch River. All samples are composited for monthly analysis.

The concentrations of fission product radionuclides present in detectably significant amounts are determined by specific radionuclide analysis and gamma spectrometry. Uranium analysis is by the fluorometric method. Transuranic alpha emitters are determined by ion exchange and alpha range analysis. The concentration of each radionuclide is compared with its respective concentration guide (CG) value as specified in the DOE Manual, Appendix 0524, and percent of concentration guide for a known mixture of radionuclides is calculated in accordance with the method given in Appendix 0524.

Data on the concentrations of radionuclides measured in the Clinch River are given in Table 11. Data on the concentrations of uranium in surface streams and the quantities of radioactivity release to surface streams are given in Tables 12 and 13.

Analysis of water samples collected at the juncture of White Oak Creek and the Clinch River indicated that the yearly average concentration of radionuclides was approximately 16 percent of the applicable concentration guide for uncontrolled areas. The calculated average concentration of radionuclides in the Clinch River, based on the analysis of water samples collected at White Oak Dam (Station W-1) and the dilution afforded by the river, was determined to be 0.2 percent of the applicable concentration guide for uncontrolled areas assuming complete mixing. The average dilution factor for 1979, based on the flow of White Oak Creek and the Clinch River, was 511. The measured average concentrations of radionuclides in the Clinch River upstream and downstream of White Oak Creek outfall were less than 0.25 percent of the applicable concentration guide.

The calculated average concentration of transuranic alpha emitters in the Clinch River resulting from effluent releases was 4×10^{-12} μCi/ml, which is less than 0.01 percent of the concentration guide for water containing a known mixture of radionuclides.

Trends in water discharges and calculated percent concentration guide levels in the Clinch River are presented in Figures 4 and 5. Discharges of ^{90}Sr and ^{3}H are shown in Figure 4 as these nuclides contribute the majority of the radiological dose downstream.

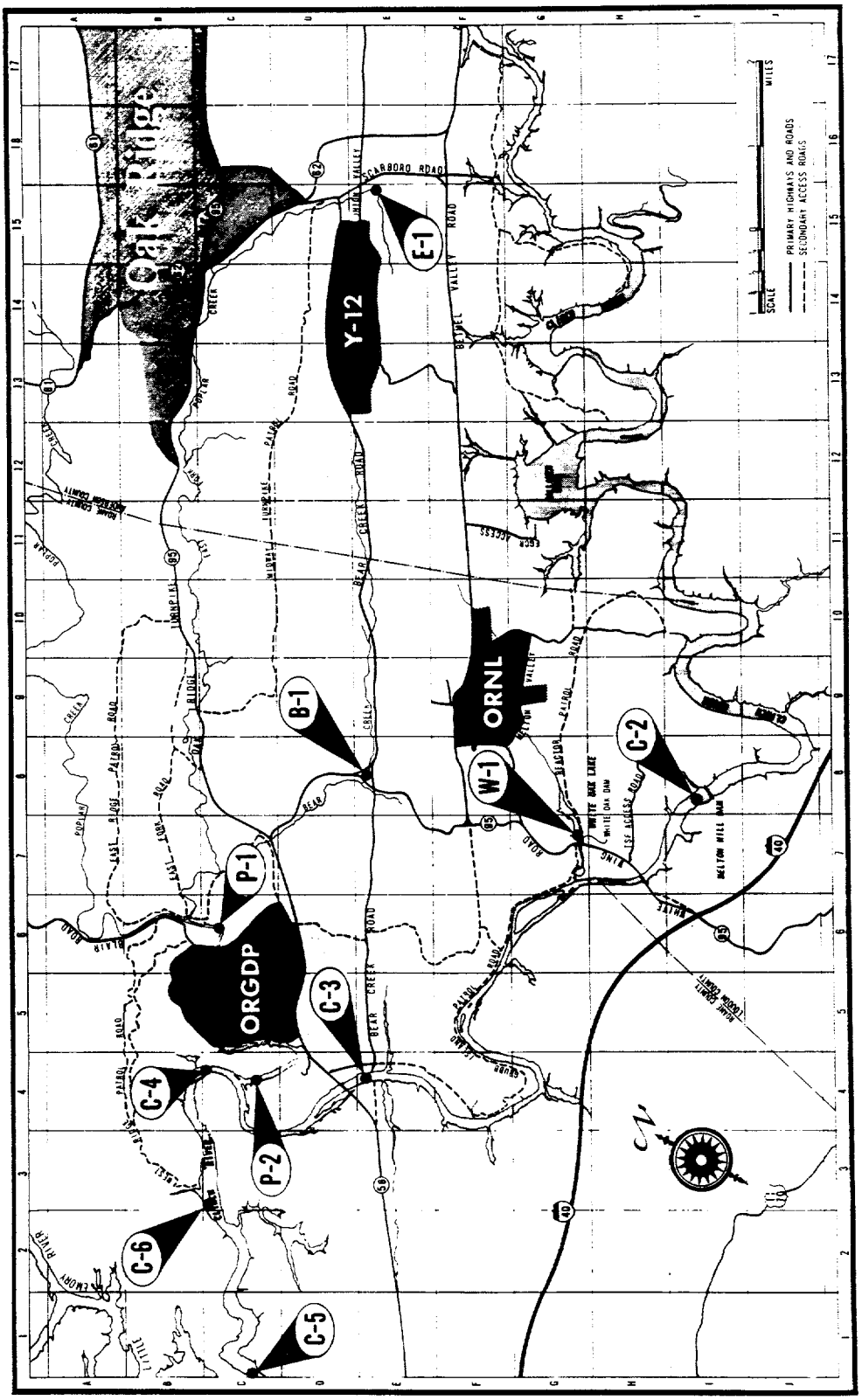

Figure 3
STREAM MONITORING LOCATIONS

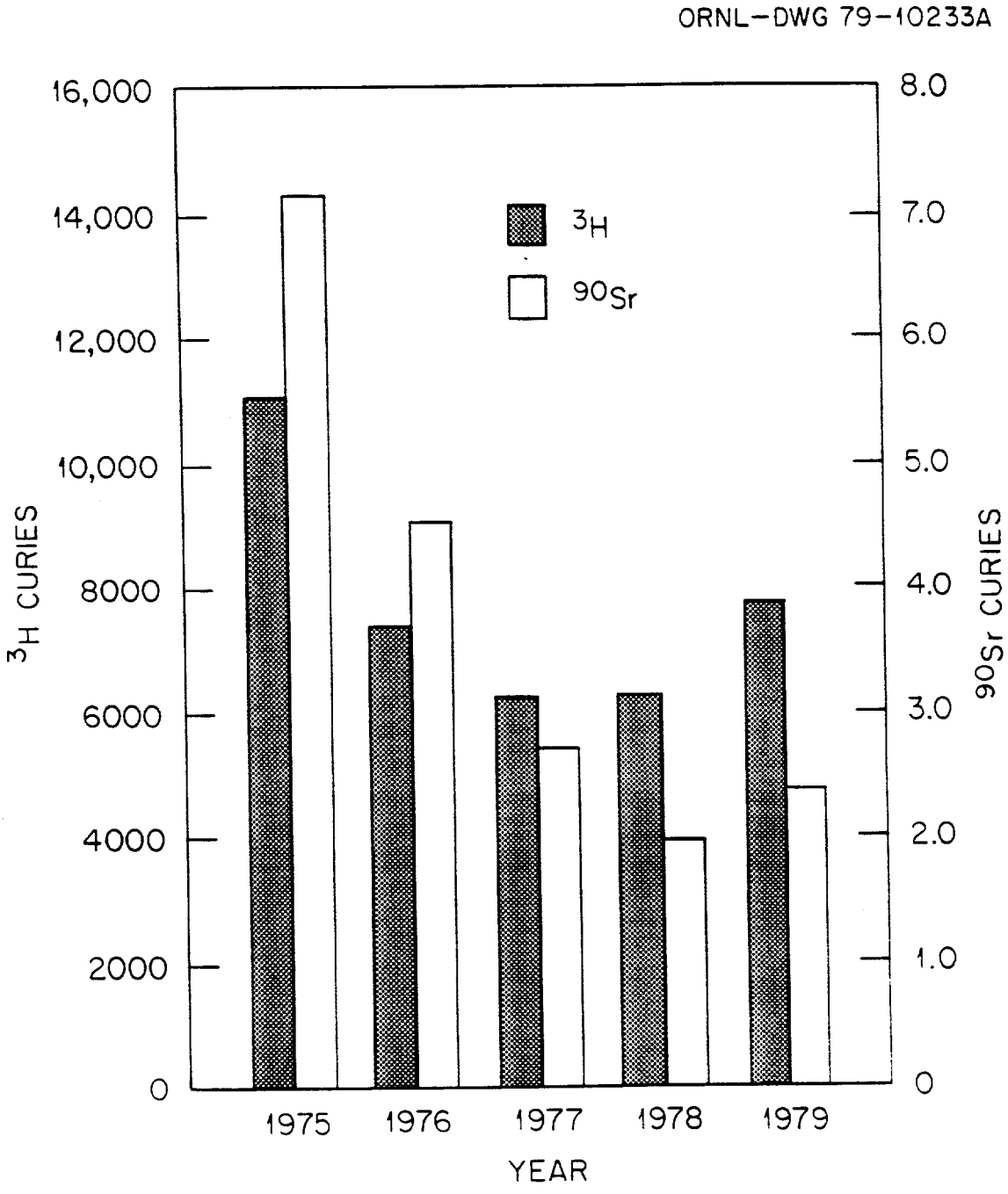

Figure 4
CURIES DISCHARGED OVER WHITE OAK DAM

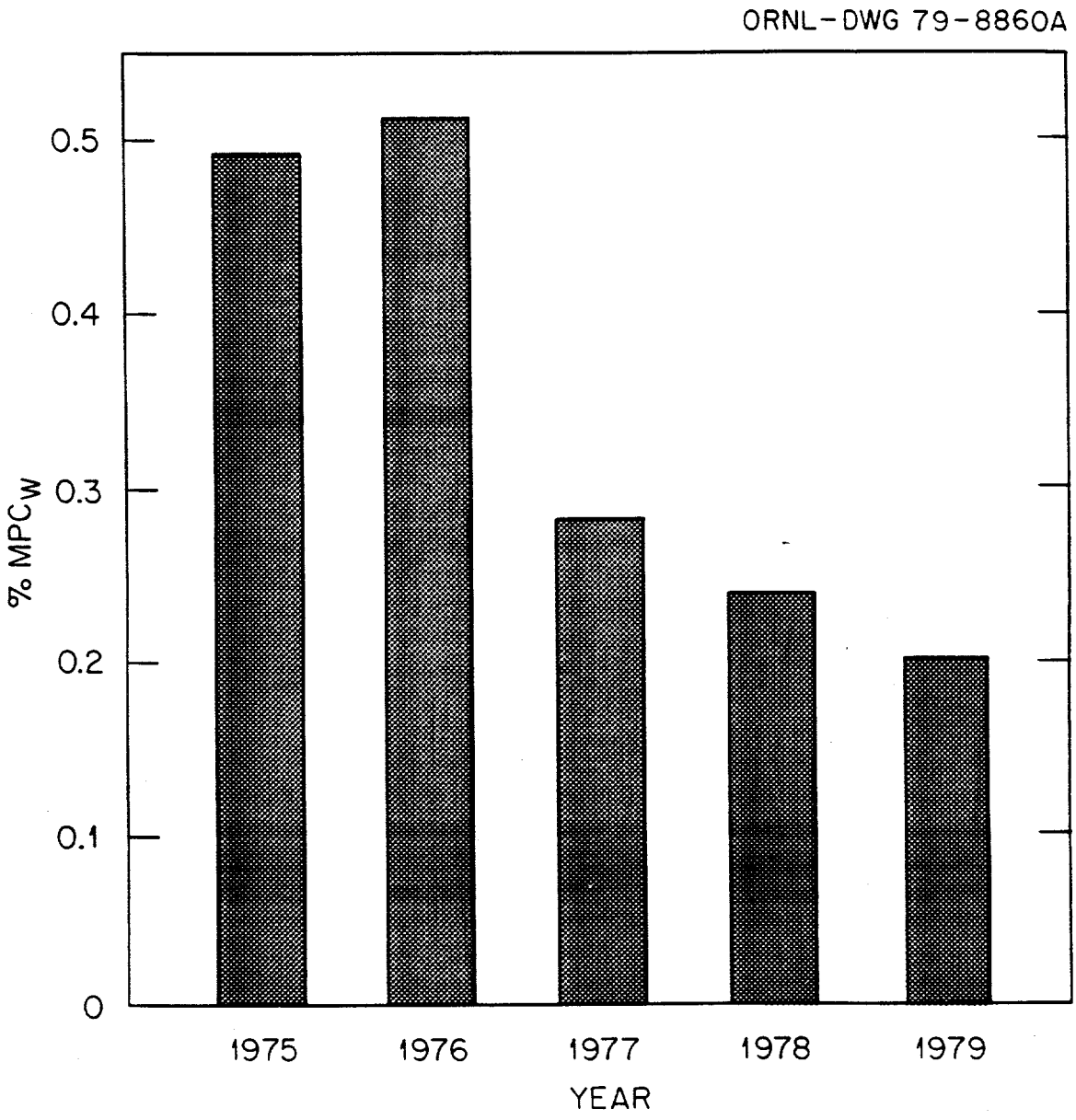

Figure 5

PERCENTAGE CONCENTRATION GUIDE LEVELS IN THE CLINCH RIVER (VALUES GIVEN ARE CALCULATED VALUES BASED ON THOSE CONCENTRATIONS MEASURED AT WHITE OAK DAM AND DILUTION AFFORDED BY THE CLINCH RIVER.)

Rainwater – The gross beta activity in rainwater was analyzed; the results are shown in Table 13. The fluctuations among the stations for both the perimeter and remote networks are due to statistical random variation. It is noted that the average radioactivity is greater for the remote stations than the perimeter stations.

Nonradioactive – Water samples are collected for the analysis of nonradioactive substances at the same locations discussed previously under radioactive water sampling. All samples are composited for monthly analysis. Samples are analyzed for a variety of water quality parameters related to process release potential and background information needs by analytical procedures recommended by the Environmental Protection Agency.[4]

Data on chemical concentrations in surface streams are given in Tables 14 through 22. The average concentrations of all substances analyzed were in compliance with Tennessee stream guidelines[5, 6] except for nitrate nitrogen at Station B-1 which was 130 percent of the guideline and zinc at Station C-4 which was 100 percent of the guideline.

National Pollutant Discharge Elimination System (NPDES) permits were issued by the Environmental Protection Agency (EPA) for each of the Oak Ridge facilities operated by Union Carbide Corporation - Nuclear Division in 1975. The permits established a number of discharge locations at each installation and listed specific concentration limits and/or monitoring requirements for a number of parameters at each discharge location. Table 23 contains the discharge locations at each installation, the parameters at each location for which limits have been established, the permit limits for each parameter, and the percentage compliance experienced.

Biological Monitoring

Milk – Raw milk is monitored for ^{131}I and ^{90}Sr by the collection and analysis of samples from 14 sampling stations located within a radius of 80 kilometers of Oak Ridge. Samples are normally collected weekly at each of eight stations located near the Oak Ridge area. Six stations, located more remotely with respect to Oak Ridge operations, are sampled at a rate of one station each week. Milk sampling locations for all stations are shown in Figures 6 and 7. Samples are analyzed by ion exchange and gamma spectrometry; results are compared to intake guides specified by the Federal Radiation Council (FRC).[7]

The average concentrations of ^{131}I and ^{90}Sr in raw milk are given in Tables 24 and 25, respectively. If one assumes the average intake of milk per individual to be one liter per day, the average concentration of ^{131}I in the milk in both the immediate environs of the Oak Ridge area and in the environs remote from Oak Ridge were within FRC Range I. The average concentrations ^{90}Sr in milk from both the immediate and remote environs were within the FRC Range 1.

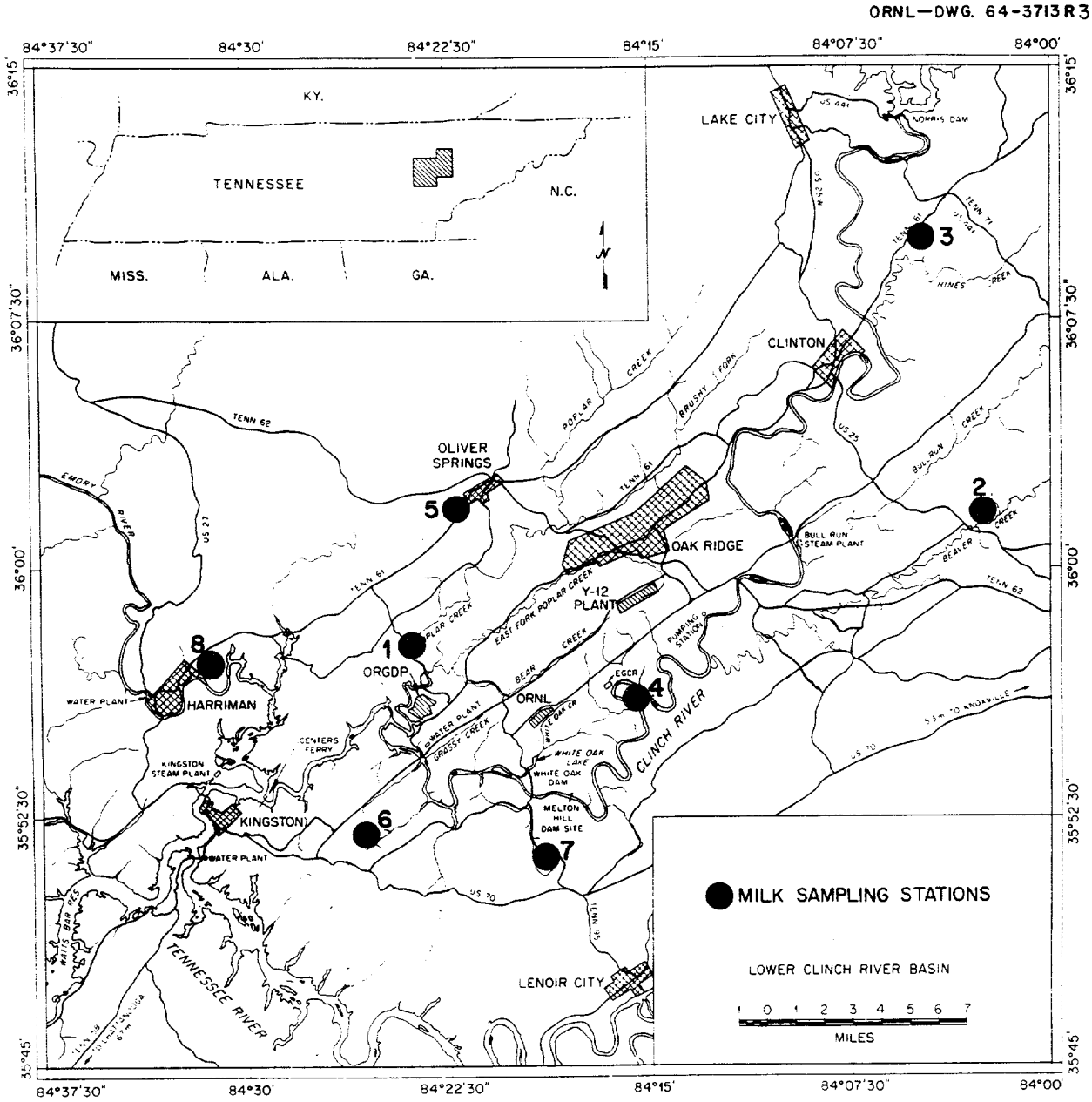

Figure 6
IMMEDIATE ENVIRONS MILK SAMPLING LOCATIONS

ORNL DWG 76-12775RA

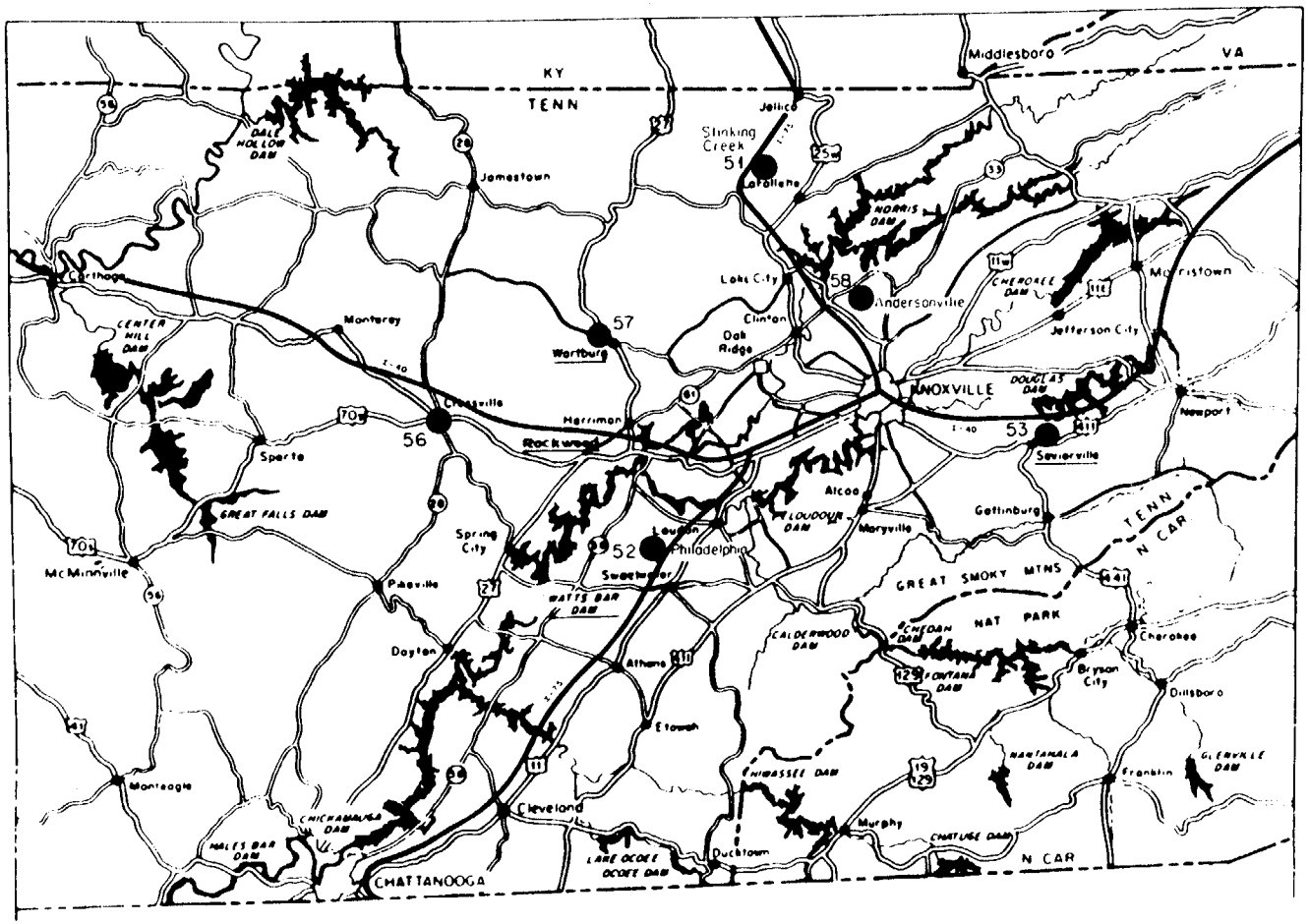

Figure 7
REMOTE ENVIRONS MILK SAMPLING LOCATIONS

Fish Sampling – Several species of fish which are commonly caught are taken from the Clinch River each year. The scales, head, and entrails are removed from the fish before ashing. Ten fish of each species are composited for each sample, and the samples are analyzed by gamma spectrometry and radiochemical techniques for the critical radionuclides which may contribute significantly to the potential radiation dose to man.

Data on the concentrations of radionuclides in Clinch River fish are given in Table 26. Consumption of 16.8 kilograms of bluegill per year[8] taken from the river near White Oak Creek outfall results in approximately 2 percent of the maximum permissible intake, which represents the highest dose potential to the public from fish consumption. The maximum permissible intake is calculated to be equal to a daily intake of 2.2 liters of water, over a period of one year, containing the concentration guide of the radionuclides in question. Mercury concentrations in the fish samples collected were generally less than 4 percent of the FDA proposed action level.

Deer – Frequently, deer are killed by automobiles on the DOE Reservation. Twenty-three deer samples were analyzed during 1979; twenty samples collected on the DOE Reservation and three samples collected off the Reservation. Summary data of the ^{137}Cs content in deer muscle are presented in Table 27. The deer with the highest concentration of ^{137}Cs would result in a dose of 0.03 millirem to the total body and 0.07 millirem to the liver (critical organ) if one assumes the consumption of 1 killogram of meat. It should be noted that no hunting is allowed on the Reservation.

Vegetation – Samples of pine needles and grass are collected semiannually from 17 areas (Stations VS-1 through VS-17, Figure 1) and analyzed for uranium and fluoride content. Fluorometric analysis is used for the determination of uranium and colorimetric analysis is used for the determination of fluorides.

Data on the uranium and fluoride content in vegetation are presented in Table 28. The fluoride concentration in grass at all sampling points was below the 30 ppm level considered to produce no adverse effects when ingested by cattle.[9] Uranium concentrations were below levels of environmental concern.

Additionally, samples of grass were collected semiannually from the perimeter and annually from the remote air-sampling stations (see Figures 1 and 2). At each station, all the grass from five 1/5-meter-squared plots was collected. One plot was taken beside the station, and the other four were taken at 15 m from the station at 90° directions from each other. The grass from each station was then composited and analyzed by gamma spectrometry and radiochemical techniques for a variety of radionuclides. Data on the radionuclide concentrations in grass are presented in Table 29.

Honey Samples – Honey samples from several hives located on the reservation were analyzed for radioactivity. Only trace amounts of ^{60}Cs and ^{137}Cs were found.

Soil and Sediment Monitoring

Soil – Soil samples are also collected semiannually from near the perimeter and annually from the remote stations. The same five 1/5 meter-squared plots used for grass analysis were also used for soil determinations. Two cores, 8 cm in diameter and 5 cm in depth, were taken from each plot; a composite of 10 cores was used for each station. These samples were also analyzed by gamma spectrometry and radiochemical techniques.

Data on specific radionuclide concentrations in soil are given in Table 30. The plutonium concentrations found were comparable to the value of 0.05 pCi/g considered to be a representative concentration of plutonium in U.S. surface soil.[10]

Sediment – A sediment sampling program was initiated at ORGDP in 1975 to determine the concentrations of various metallic ions in the sediment of Poplar Creek. The current sampling program consists of 14 sampling locations (Figure 8) which should be generally representative of plant effluents. Samples are collected twice during the year and analyzed by atomic absorption.

The concentrations of metals in the stream sediment samples, Table 31, generally exceed background levels for metals in remote streams, except for cadmium and thorium which were below detectable limits. An examination of the effluent sources indicates that only very small quantities of any of these metals are currently being released, suggesting that present concentrations found in sediment samples are residual metals from earlier plant operations.

Calculation of Potential Radiation Dose to the Public

Potential radiation doses resulting from plant effluents were calculated for a number of dose reference points within the Oak Ridge environs. All significant sources and modes of exposure were examined, and a number of general assumptions were used in making the calculations.

The site boundary for the Oak Ridge Complex was defined as the perimeter of the DOE controlled area.

Gaseous effluents are discharged from several locations within each of the three Oak Ridge facilities. For calculational purposes, the gaseous discharges are assumed to occur from only one vent from each site. Since the release points at ORGDP and the Y-12 Plant do not physically approximate an elevated stack, their discharges are assumed to be from 10 meters above ground level; releases from ORNL are through elevated stacks. The meteorological data collected at the ORNL site were used for dispersion calculations. Concentrations of radionuclides contained in the air and deposited on the ground were estimated at distances up to 80 kilometers from the Oak Ridge facilities with the Gaussian plume model developed by Pasquill[11] and Gifford[12] incorporated in a computer program.[13] The concentration has been averaged over the crosswind direction to give the estimated ground level concentration downwind of the source of emission.[14] The deposition velocities used in the calculations were 10^{-6} cm/sec for krypton and xenon, 10^{-2} cm/sec for iodine, and

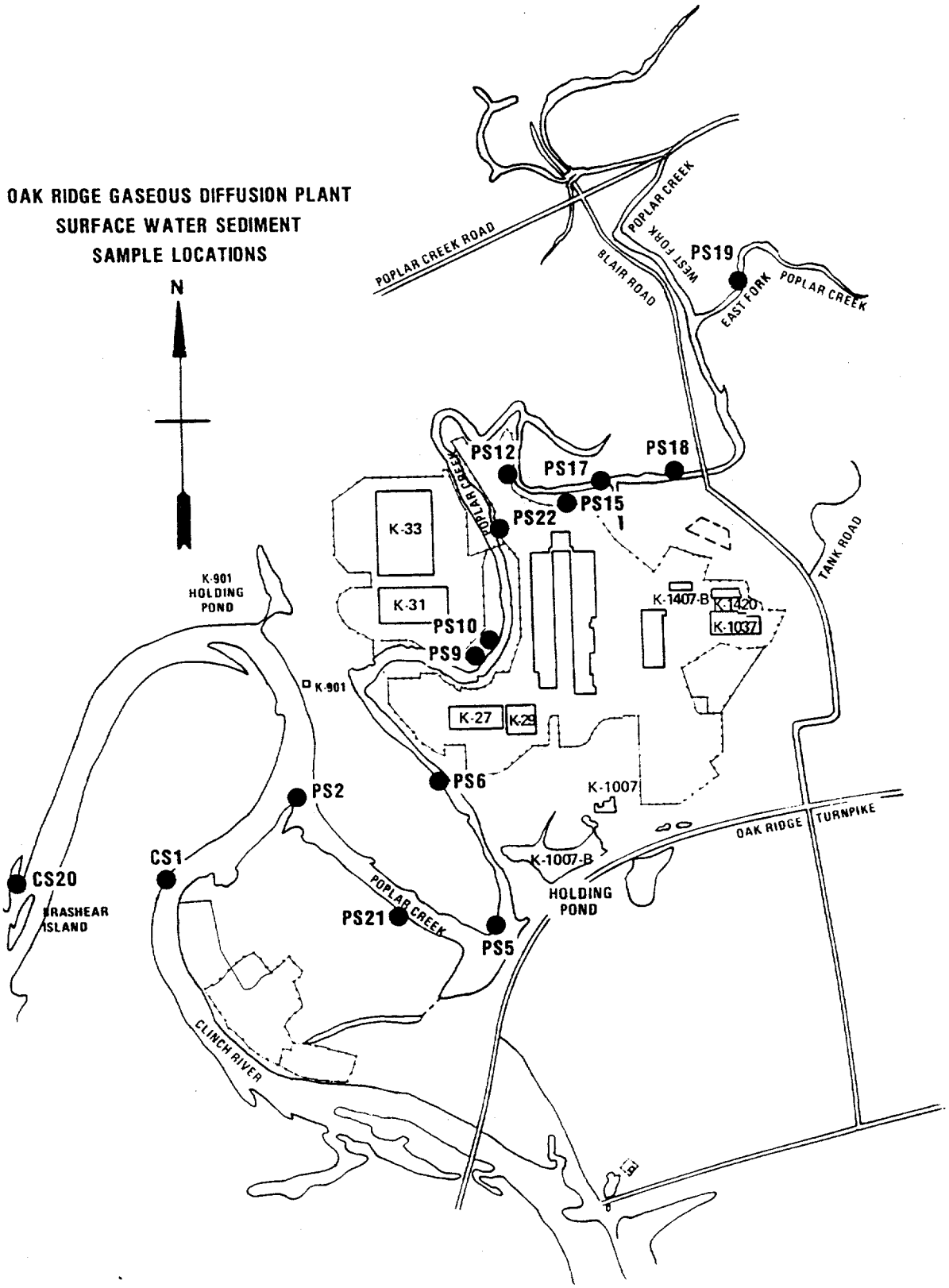

Figure 8

OAK RIDGE GASEOUS DIFFUSION PLANT SEDIMENT SAMPLING LOCATIONS

1 cm/sec for particulates.[15] Meteorological data are shown in Figure 9; the length of the bars indicates the percentage of time the wind is blowing in that direction.

Potential pathways of exposure to man from radioactive effluents released by the Oak Ridge operations that are considered in the dose estimates are presented in Figure 10. The pathways shown in the figure are not exhaustive, but they include the principal pathways of exposure based on experience.

Exposures to radionuclides that originate in the effluents released from the Oak Ridge facilities were converted to estimates of radiation dose to individuals using models and data presented in publications of the International Commission on Radiological Protection,[16-21] other recognized literature on radiation protection,[22-24] personal communication,[25] and computer programs incorporating some of these models and data.[26, 27] Radioactive material taken into the body by inhalation or ingestion will continuously irradiate the body until removed by processes of metabolism and radioactive decay; thus the estimates for internal dose are called "dose commitments;" they are obtained by integrating over the assumed remaining lifetime (50 years) of the exposed individual.

The radiation doses to the total body and to internal organs from external exposures to penetrating radiation are approximately equal, but they may vary considerably for internal exposures because some radionuclides concentrate in certain organs of the body. For this reason, estimates of radiation dose to the total body, thyroid, lungs, bone, liver, kidneys, and gastrointestinal tract were considered for various pathways of exposure. These estimates were based on parameters applicable to an average adult.[16, 21] The population dose estimate (in man-rem) is the sum of the total body doses to exposed individuals within an 80-kilometer radius of the Oak Ridge facilities.

Maximum Potential Exposure – The point of maximum potential exposure ("fence-post" dose) on the site boundary is located along the bank of the Clinch River adjacent to a cesium field experimental plot and is due primarily to "sky-shine" from the plot. A maximum potential total body exposure of 240 millirem/yr was calculated for this location assuming that an individual remained at this point for 24 hours/day for the entire year. The calculated maximum potential exposure is 48 percent of the allowable standard.[1] This is an atypical exposure location and the probability of an exposure of the magnitude calculated is considered remote since access is only by boat.

The total body dose to a "hypothetical maximum exposed individual" at the same location was calculated using a more realistic residence time of 240 hours/yr. The calculated dose under these conditions was 6.6 millirem/yr which is 1.3 percent of the allowable standard[1] and represents what is considered a probable upper limit of exposure.

A more probable exposure potential might be considered to occur at other locations beyond the site boundary as a result of airborne or liquid effluent releases.

The dose commitment to an individual continuously occupying the residence nearest the site boundary would result from inhalation and is based on an inhalation rate for the average adult of 2×10^4 liters/day. The calculated dose commitments at this location were 5.1

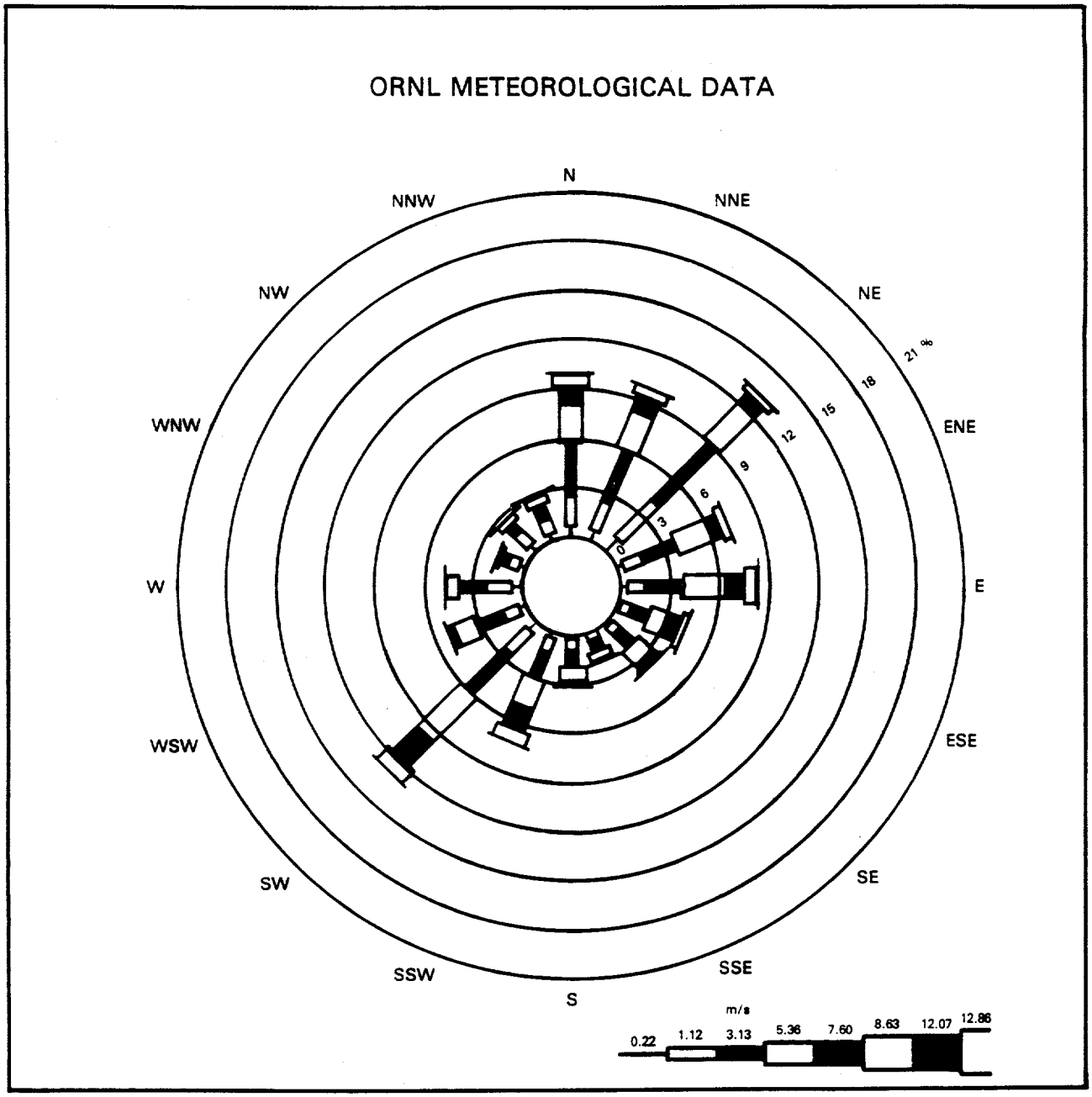

Figure 9

METEOROLOGICAL DATA FOR THE OAK RIDGE RESERVATION

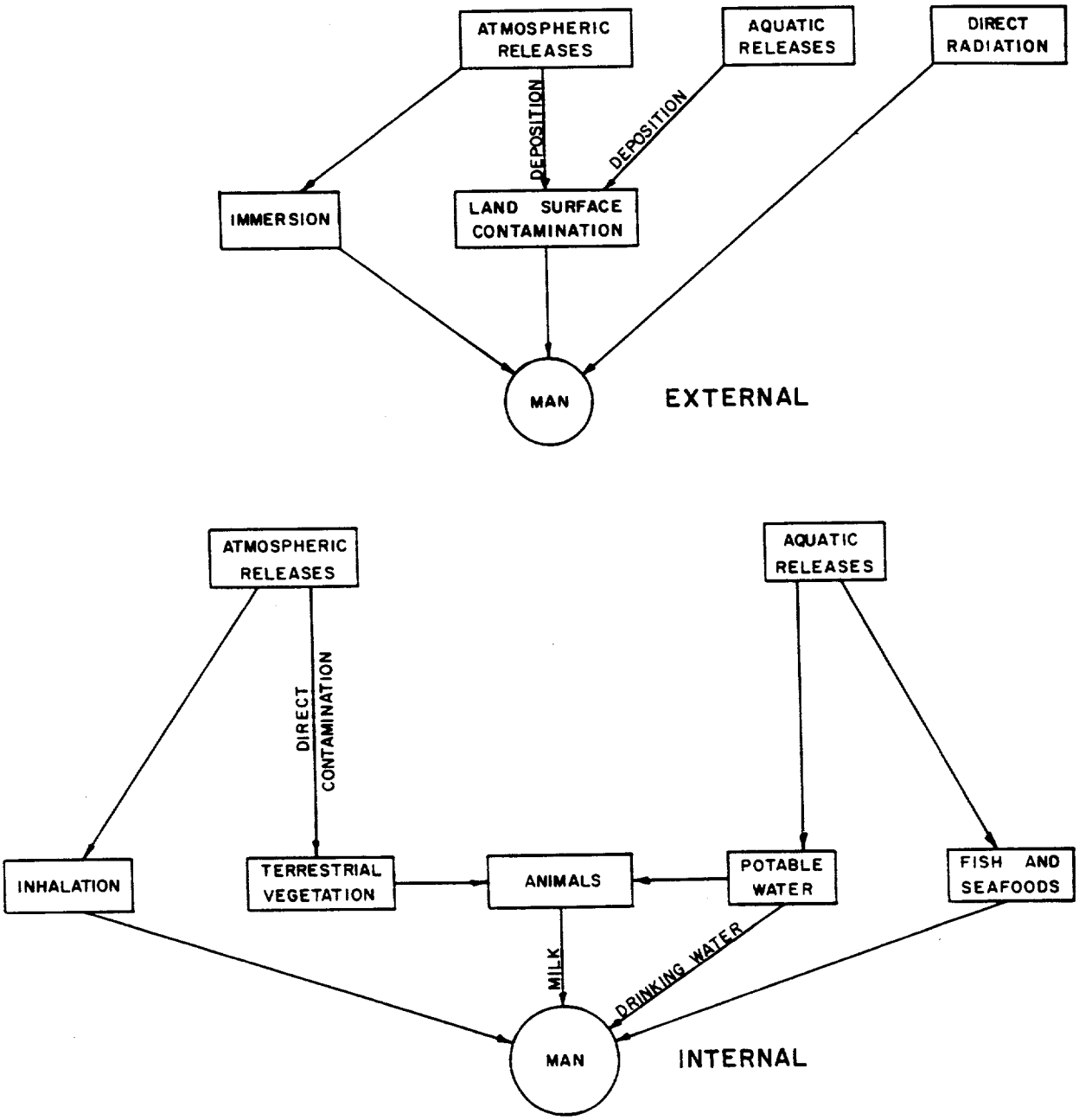

Figure 10
EXPOSURE PATHWAYS

millirem to the lung (the critical organ) and 0.5 millirem to the total body; uranium-234 is the important radionuclide contributing to this dose. These levels are 0.34 percent and 0.1 percent, respectively, of the allowable annual standard. Due to inherent uncertainties in the meteorological data, stack sampling data and calculational techniques, the calculated doses may be in error as much as 300%.

The most important contribution to dose from radioactivity within the terrestrial food-chain is by the atmosphere-pasture-cow-milk food-chain pathway. Measurements of the two principal radionuclides entering into this pathway, ^{131}I and ^{90}Sr (see Tables 24 and 25), indicate that the maximum dose to an individual in the immediate environs from ingestion of one liter of milk per day is 0.1 millirem to the thyroid and 7.3 millirem to the bone at Station 6. The average concentrations for the remote stations were assumed to be background and were subtracted from the perimeter station data in making the calculations.

The public water supply closest to the liquid discharges from the Oak Ridge facilities is located approximately 26 kilometers downstream at Kingston, Tennessee. The intake to the water filtration plant is located on the Tennessee River approximately one-half mile upstream from the confluence of the Clinch and Tennessee Rivers. Normally, Tennessee River water is used for the Kingston water supply but under certain conditions of power generation, backflow can occur. Under backflow conditions, Clinch River water may move upstream in the Tennessee River and be used as the source of water for the Kingston filtration plant. It is estimated that these conditions would prevail a maximum of 20 percent of the time. Measurements of untreated river water samples at Kingston (see Table 10) indicate that the maximum dose commitment resulting from the ingestion of 20 percent of the daily adult requirement (about two liters per day) is 2.3 millirem to the bone and 0.05 millirem to the total body. The average concentrations in Melton Hill Dam water (background) were subtracted from the values obtained at Kingston.

Estimates of the 50-year dose commitment to an adult were calculated for consumption of 16.8 kilograms of fish per year from the Clinch River. The consumption of 16.8 kilograms[8] is about 2.5 times the national average fish consumption[29] and is used because of the popularity of fishing in East Tennessee. From the analysis of edible parts of the fish examined (see Table 26), the maximum possible organ dose commitment to an individual from the highest quarterly bluegill sample taken from CRM 20.8 is estimated to be 118 millirem to the bone from ^{90}Sr. The maximum total body dose to an individual was calculated to be 2.4 millirem.

A more probable dose commitment, based on the annual average concentration of ^{90}Sr in bluegill samples taken from CRM 20.8, was calculated to be 35 millirem to the bone and 0.7 millirem to the total body. These dose commitments are about 0.14 percent and 2.3 percent, respectively, of the allowable annual standards. Fish samples taken from Melton Hill Lake were analyzed to determine background conditions. Fish caught and consumed from other locations in the Clinch River would result in significantly less dose than the maximum calculated for CRM 20.8, see Table 26.

Summaries are given in Table 32 of the potential radiation doses to adult members of the general public at the points of highest potential exposure from gaseous and liquid effluents from the Oak Ridge facilities.

Dose to the Population – The Oak Ridge population received the largest average individual total body dose as a population group. The average total body dose to an Oak Ridge resident was estimated to be 0.02 millirem as compared to approximately 100 millirem/yr from natural background radiation; the average dose commitment to the lung of an Oak Ridge resident was 0.4 millirem. The maximum potential dose commitment to an Oak Ridge resident was calculated to be 5.1 millirem to the lung. This calculated dose is 0.3 percent of the allowable annual standard.(1)

The cumulative total body dose to the population within an 80 kilometer radius of the Oak Ridge facilities resulting from 1979 plant effluents was calculated to be 5.3 man-rem. This cumulative dose was calculated using the population distribution given in Table 1 for ORNL atmospheric effluents; similar population distributions were used for the Y-12 and ORGDP releases. This dose may be compared to an estimated 74,000 man-rem to the same population resulting from natural background radiation. About 14 percent of the collective dose from the effluents of the Oak Ridge facilities is estimated to be to the Oak Ridge population.

Table 1

INCREMENTAL POPULATION TABLE IN THE VICINITY OF ORNL

DISTANCE, MILES DISTANCE, KM	0-1 0-1.6	1-2 1.6-3.2	2-3 3.2-4.8	3-4 4.8-6.4	4-5 6.4-8.0	5-10 8-16	10-20 16-32	20-30 32-48	30-40 48-64	40-50 64-80
Direction										
E	0	0	0	0	0	3,059	44,880	100,500	11,790	12,390
ENE	0	0	0	0	0	0	27,460	74,690	18,720	13,870
NE	0	0	0	0	0	9,713	12,480	7,167	4,392	7,476
NNE	0	0	0	0	1,461	13,780	4,362	11,190	12,670	6,119
N	0	0	0	0	1,490	5,578	2,177	1,441	2,223	4,508
NNW	0	0	0	0	0	1,495	0	1,152	4,559	4,676
NW	0	0	0	0	0	1,073	4,804	1,538	1,896	7,552
WNW	0	0	0	0	0	587	2,971	1,543	0	4,151
W	0	0	0	0	0	666	13,100	4,595	9,038	7,318
WSW	0	0	0	0	0	622	9,862	3,495	4,562	4,204
SW	0	0	0	0	0	733	1,840	1,909	3,962	8,578
SSW	0	0	0	0	0	721	2,055	7,897	21,580	10,530
S	0	0	0	0	0	943	8,742	7,309	6,560	1,222
SSE	0	0	0	0	1,374	7,277	1,290	4,091	469	0
SE	0	0	0	0	0	1,167	4,304	15,010	46	0
ESE	0	0	0	0	0	6,096	5,343	36,020	4,132	6,840
TOTAL	0	0	0	0	4,325	53,510	145,670	279,547	106,599	99,434
CUMULATIVE TOTAL	0	0	0	0	4,325	57,835	203,505	483,052	589,651	689,085

Table 2

CONTINUOUS AIR MONITORING DATA
Long-Lived Gross Beta Activity of Particulates in Air
1979

STATION NUMBER	LOCATION	NUMBER OF SAMPLES TAKEN	UNITS OF 10^{-13} μCi/ml			% CG[c]
			MAXIMUM[a]	MINIMUM[b]	AVERAGE	
			Perimeter Area[d]			
HP-31	Kerr Hollow Gate	50	0.7	0.12	0.25 ± .02	0.02
HP-32	Midway Gate	52	0.8	0.08	0.31 ± .04	0.03
HP-33	Gallaher Gate	51	0.5	0.09	0.27 ± .02	0.03
HP-34	White Oak Dam	52	0.7	0.10	0.28 ± .02	0.03
HP-35	Blair Gate	50	0.6	0.09	0.27 ± .02	0.03
HP-36	Turnpike Gate	52	0.5	0.05	0.23 ± .02	0.02
HP-37	Hickory Creek Bend	52	0.8	0.11	0.35 ± .04	0.04
HP-38	East of EGCR	52	0.5	0.10	0.26 ± .02	0.03
HP-39	Townsite	52	0.6	0.08	0.25 ± .02	0.02
Average			0.6	0.10	0.27 ± .02	0.03
			Remote Area[e]			
HP-51	Norris Dam	52	1.1	0.08	0.26 ± .04	0.03
HP-52	Loudoun Dam	52	0.7	0.07	0.25 ± .04	0.03
HP-53	Douglas Dam	50	0.6	0.07	0.24 ± .02	0.02
HP-54	Cherokee Dam	52	0.4	0.06	0.20 ± .02	0.02
HP-55	Watts Bar Dam	50	0.4	0.01	0.13 ± .02	0.01
HP-56	Great Falls Dam	50	0.6	0.07	0.27 ± .04	0.03
HP-57	Dale Hollow Dam	51	0.7	0.05	0.34 ± .04	0.03
HP-58	Knoxville	51	0.6	0.05	0.22 ± .04	0.02
Average			0.7	0.06	0.24 ± .02	0.02

[a]Maximum weekly average concentration.

[b]Minimum weekly average concentration-minimum detectable level is 1×10^{-15} μCi/ml.

[c]CG is 10^{-10} μCi/ml for unidentified radionuclides (DOE Manual, Appendix 0524, Annex A, Table II).

[d]See Figure 1.

[e]See Figure 2.

Table 3

CONTINUOUS AIR MONITORING DATA
Long-Lived Gross Alpha Activity of Particulates in Air
1979

STATION NUMBER	LOCATION	NUMBER OF SAMPLES TAKEN	UNITS OF 10^{-15} μCi/ml			% CG[c]
			MAXIMUM[a]	MINIMUM[b]	AVERAGE	
		Perimeter Area[d]				
HP-31	Kerr Hollow Gate	50	7.2	0.5	1.1 ± 0.3	0.03
HP-32	Midway Gate	52	4.8	0.7	1.4 ± 0.2	0.03
HP-33	Gallaher Gate	51	4.5	0.6	1.2 ± 0.2	0.03
HP-34	White Oak Dam	52	3.3	0.5	1.2 ± 0.2	0.03
HP-35	Blair Gate	50	10.1	0.3	1.5 ± 0.4	0.04
HP-36	Turnpike Gate	52	2.9	0.5	1.1 ± 0.2	0.03
HP-37	Hickory Creek Bend	52	3.0	0.5	0.9 ± 0.1	0.02
HP-38	East of EGCR	52	17.8	0.5	1.4 ± 0.7	0.04
HP-39	Townsite	52	3.8	0.6	1.2 ± 0.2	0.03
Average			6.4	0.5	1.2 ± 0.12	0.03
		Remote Area[e]				
HP-51	Norris Dam	52	2.4	0.4	1.0 ± 0.2	0.02
HP-52	Loudoun Dam	52	2.5	0.5	0.9 ± 0.1	0.02
HP-53	Douglas Dam	50	2.6	0.5	0.9 ± 0.1	0.02
HP-54	Cherokee Dam	52	2.5	0.5	0.9 ± 0.1	0.02
HP-55	Watts Bar Dam	50	1.3	0.1	0.7 ± 0.1	0.02
HP-56	Great Falls Dam	50	2.8	0.5	1.0 ± 0.2	0.02
HP-57	Dale Hollow Dam	51	2.7	0.5	1.0 ± 0.2	0.03
HP-58	Knoxville	51	2.9	0.5	0.9 ± 0.2	0.02
Average			2.5	0.4	0.9 ± 0.1	0.02

[a]Maximum weekly average concentration.

[b]Minimum weekly average concentration-minimum detectable level is 1×10^{-16} μCi/ml.

[c]CG is 40×10^{-13} μCi/ml for a mixture of uranium isotopes. (DOE Manual, Appendix 0524, Annex A, Table II).

[d]See Figure 1.

[e]See Figure 2.

Table 4

CONTINUOUS AIR-MONITORING DATA
Specific Radionuclides in Air
(Composite Samples)
1979
Units of 10^{-15} μCi/ml

	PERIMETER STATIONS					REMOTE STATIONS				
RADIONUCLIDE	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Yearly Average	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Yearly Average
^{7}Be	109	119	91	104	106	113	100	84	85	95
^{90}Sr	0.15	0.27	0.05	0.13	0.15	0.09	0.38	0.06	0.22	0.19
^{106}Ru	2.27	2.72	0.72	0.54	1.56	1.93	2.37	0.73	0.41	1.36
^{125}Sb	0.48	0.60	0.27	0.14	0.37	0.41	0.57	0.18	0.16	0.33
^{137}Cs	0.75	1.14	0.49	0.29	0.67	0.82	1.06	0.31	0.23	0.61
^{144}Ce	3.13	3.48	0.72	0.08	1.85	0.25	3.07	0.67	0.33	1.10
^{228}Th	0.006	0.020	0.008	0.007	0.010	0.008	0.020	0.006	0.003	0.009
^{230}Th	0.050	0.020	0.011	0.010	0.023	0.009	0.020	0.006	0.004	0.010
^{232}Th	0.004	0.020	0.008	0.008	0.010	0.008	0.040	0.002	0.003	0.013
^{234}U	0.65	0.18	0.25	0.68	0.44	0.26	0.045	0.053	0.033	0.10
^{235}U	0.060	0.013	0.012	0.045	0.030	0.020	0.0003	0.006	0.003	0.010
^{238}U	0.23	0.13	0.20	0.48	0.26	0.012	0.010	0.020	0.022	0.020
^{238}Pu	0.001	0.005	0.001	0.001	0.002	ND*	0.0002	0.002	0.0004	0.0007
^{239}Pu	0.008	0.15	0.005	0.012	0.040	0.006	0.012	0.004	0.002	0.010

*ND - Not Detectable

Table 5

CONCENTRATION OF ^{131}I IN AIR AS MEASURED BY THE PERIMETER AIR MONITORING STATIONS[a]
1979

STATION NUMBER	LOCATION	NUMBER OF SAMPLES TAKEN	UNITS OF 10^{-14} μCi/ml			%
			MAXIMUM[b]	MINIMUM[c]	AVERAGE	CG[d]
HP-31	Kerr Hollow Gate	51	7.7	0.03	0.5 ± 0.3	<0.01
HP-32	Midway Gate	52	1.5	0.02	0.4 ± 0.1	<0.01
HP-33	Gallaher Gate	51	7.1	0.04	0.5 ± 0.3	<0.01
HP-34	White Oak Dam	52	6.4	0.01	0.5 ± 0.2	<0.01
HP-35	Blair Gate	52	1.1	0.01	0.3 ± 0.1	<0.01
HP-36	Turnpike Gate	52	6.0	0.02	0.3 ± 0.1	<0.01
HP-37	Hickory Creek Bend	52	3.0	0.03	0.4 ± 0.1	<0.01
HP-38	East of EGCR	52	6.0	0.03	0.4 ± 0.3	<0.01
HP-39	Townsite	51	0.8	0.06	0.4 ± 0.1	<0.01
Average					0.4 ± 0.1	<0.01

[a]See Figure 1.

[b]Maximum weekly average concentration.

[c]Minimum weekly average concentration-minimum detectable amount of ^{131}I is 1×10^{-16} μCi/ml.

[d]CG is 1×10^{-10} μCi/ml (DOE Manual, Appendix 0524, Annex A, Table II).

Table 6
DISCHARGES OF RADIOACTIVITY TO THE ATMOSPHERE
1979

RADIONUCLIDE	CURIES DISCHARGED
Uranium[a]	0.11
^{131}I	0.3
^{3}H	5,100
^{133}Xe[b]	<51,200
^{85}Kr[b]	<10,500
^{99}Tc	1.4
Alpha[c]	4.8×10^{-6}

[a]Uranium of varying enrichments - curie quantities calculated using the appropriate specific activity for material released.

[b]Upper limit values based on direct radiation measurements in the stack gas stream and an assumed mixture of noble gases.

[c]Unidentified alpha.

Table 7

AIR MONITORING DATA - FLUORIDES
1979

Location[a]	Number of Samples	Maximum Concentration for Averaging Interval μg/m³		Number of Times Standard Exceeded[b]		Annual Average μg/m³
	7 Day	7 Day	30 Day	7 Day	30 Day	
F-1	48	2.0	0.9	1	0	<0.2 ± 0.1
F-2	44	4.7	1.4	1	1	<0.4 ± 0.2
F-3	47	0.5	0.4	0	0	<0.2 ± 0.05
F-4	48	4.4	1.4	1	1	<0.2 ± 0.2
F-5	45	0.3	0.09	0	0	<0.06 ± 0.02
F-6[c]	48	0.3	0.1	0	0	<0.05 ± 0.01

[a]See Figure 1.

[b]Tennessee Air Pollution Control Regulations-

3.7 μg/m³ for 12 hour averaging interval
2.9 μg/m³ for 24 hour averaging interval
1.6 μg/m³ for 7 day averaging interval
1.2 μg/m³ for 30 day averaging interval

All values are maximum-not to be exceeded more than once per year.

[c]Station F-6 approximately 8 kilometers from ORGDP upwind of the predominant prevailing wind direction, thus may be considered representative of general ambient background concentration.

NOTE: Data not amenable to comparison with 12-hour or 24-hour standard.

Table 8
AIR MONITORING DATA - SUSPENDED PARTICULATES
1979

LOCATION[a]	NUMBER OF SAMPLES	CONCENTRATION, $\mu g/m^3$			% STD.[b]
		MAXIMUM	MINIMUM	AVERAGE	
SP-1	41	91	1	29 ± 8	39
SP-2	45	166	1	27 ± 10	35
SP-3	41	91	2	29 ± 8	39
SP-4	40	422	3	28 ± 22	37

[a]See Figure 1.

[b]Tennessee Ambient Air Standards - Primary Standard.

Maximum 24 hr. Average — 260 $\mu g/m^3$

Annual Geometric Mean — 75 $\mu g/m^3$

Table 9
EXTERNAL GAMMA RADIATION MEASUREMENTS
1979

STATION NUMBER	LOCATION	NUMBER OF MEASUREMENTS TAKEN	BACKGROUND μR/hr	BACKGROUND mR/yr
		Perimeter Stations[a]		
HP-31	Kerr Hollow Gate	12	9.9 ± 1.3	87 ± 12
HP-32	Midway Gate	10	9.8 ± 2.2	86 ± 19
HP-33	Gallaher Gate	12	9.3 ± 1.5	82 ± 13
HP-34	White Oak Dam	11	11.4 ± 2.0	100 ± 18
HP-35	Blair Gate	12	9.9 ± 1.9	87 ± 17
HP-36	Turnpike Gate	11	8.7 ± 1.5	76 ± 13
HP-37	Hickory Creek Bend	12	8.5 ± 1.2	75 ± 11
HP-38	East of EGCR	12	8.6 ± 1.2	76 ± 11
HP-39	Townsite	12	8.2 ± 1.7	72 ± 15
Average			9.4 ± 0.7	82 ± 6
		Remote Stations[b]		
HP-51	Norris Dam	2	5.6 ± 0.5	49 ± 4
HP-52	Loudoun Dam	2	7.1 ± 2.2	62 ± 19
HP-53	Douglass Dam	2	5.7 ± 5.5	50 ± 48
HP-54	Cherokee Dam	2	5.4 ± 5.3	47 ± 46
HP-55	Watts Bar Dam	2	6.1 ± 1.0	54 ± 8
HP-56	Great Falls Dam	2	6.0 ± 0.1	53 ± 1
HP-57	Dale Hollow Dam	2	10.3 ± 5.8	91 ± 51
HP-58	Knoxville	2	11.0 ± 4.3	97 ± 38
Average			7.2 ± 1.6	63 ± 14

[a]See Figure 1.
[b]See Figure 2.

Table 10

RADIONUCLIDES IN THE CLINCH RIVER
1979

LOCATION	NUMBER OF SAMPLES	RANGE	CONCENTRATION OF RADIONUCLIDES OF PRIMARY CONCERN UNITS OF 10^{-9} μCi/ml					% CG[a]
			^{90}Sr	^{137}Cs	^{106}Ru	^{60}Co	^{3}H	
C-2 CRM 23.1	4	Max	0.16	0.02	0.09	0.01	720	
		Min.	0.05	0.01	0.02	0.01	590	
		Avg.	0.10 ± 0.06	0.01 ± 0.01	0.05 ± 0.03	0.01	650 ± 80	0.06
C-3 CRM 14.5	4	Max.	0.68	0.05	0.14	0.11	2,200	
		Min.	0.16	0.01	0.03	0.01	1,000	
		Avg.	0.40 ± 0.31	0.02 ± 0.02	0.08 ± 0.05	0.05 ± 0.05	1,400 ± 700	0.15
C-5 CRM 4.5	4	Max.	0.37	0.05	0.23	0.05	1,800	
		Min.	0.14	0.01	0.02	0.02	1,400	
		Avg.	0.33 ± 0.21	0.03 ± 0.02	0.11 ± 0.09	0.04 ± 0.01	1,600 ± 200	0.21

[a]Most restrictive concentration guide for each isotope used for calculating percent concentration guide. The method for calculating percent of concentration guide for a known mixture of radionuclides is given in DOE Manual, Appendix 0524, Annex A.(1)

Table 11
URANIUM CONCENTRATION IN SURFACE STREAMS
1979

STATION NUMBER[a]	LOCATION	NUMBER OF SAMPLES	UNITS OF 10^{-8} μCi/ml			% CG[b]
			MAXIMUM	MINIMUM	AVERAGE	
P-1	Poplar Creek	12	0.7	<0.07	<0.4 ± 0.3	<0.1
P-2	Poplar Creek	12	0.8	0.2	0.5 ± 0.2	<0.1
C-3	Clinch River	12	0.5	<0.07	<0.2 ± 0.1	<0.1
C-4	Clinch River	12	0.8	<0.07	<0.3 ± 0.2	<0.1
C-6	Clinch River	12	0.5	<0.07	<0.2 ± 0.1	<0.1
E-1	East Fork Poplar Creek	12	1.6	0.5	1.0 ± 0.3	<0.1
B-1	Bear Creek	10	3.7	1.5	2.6 ± 0.5	<0.1

[a]See Figure 3.
[b]CG is 3×10^{-5} μCi/ml for a mixture of uranium isotopes (DOE Manual, Appendix 0524, Annex A, Table II).

Table 12
DISCHARGES OF RADIOACTIVITY TO SURFACE STREAMS
1979

RADIONUCLIDE	CURIES DISCHARGED
^{137}Cs	0.24
^{60}Co	0.9
^{3}H	7700
^{131}I	0.06
^{106}Ru	0.13
^{90}Sr	2.44
^{99}Tc	7.3
Uranium[a]	0.6
^{237}Np	0.002
^{239}Pu	0.0005
^{232}Th	0.011
Alpha[b]	0.03

[a]Uranium of varying enrichments - curie quantities calculated using the appropriate specific activity for material released.

[b]Unidentified alpha.

Table 13
LONG-LIVED GROSS BETA ACTIVITY IN RAINWATER
1979

STATION NUMBER	LOCATION	NUMBER OF SAMPLES TAKEN	UNITS OF 10^{-8} μCi/ml[a]
		Perimeter Area[b]	
HP-31	Kerr Hollow Gate	41	0.9 ± 0.3
HP-32	Midway Gate	27	0.7 ± 0.3
HP-33	Gallaher Gate	22	1.1 ± 0.4
HP-34	White Oak Dam	26	1.0 ± 0.4
HP-35	Blair Gate	26	1.0 ± 0.3
HP-36	Turnpike Gate	27	1.0 ± 0.3
HP-37	Hickory Creek Bend	27	1.0 ± 0.3
HP-38	East of EGCR	28	1.1 ± 0.4
HP-39	Townsite	44	0.8 ± 0.2
Average			1.0 ± 0.1
		Remote Area[c]	
HP-51	Norris Dam	43	1.2 ± 0.5
HP-52	Loudoun Dam	27	1.4 ± 0.5
HP-53	Douglas Dam	26	1.4 ± 0.5
HP-54	Cherokee Dam	27	1.5 ± 0.6
HP-55	Watts Bar Dam	28	1.2 ± 0.4
HP-56	Great Falls Dam	30	1.7 ± 0.5
HP-57	Dale Hollow Dam	27	1.3 ± 0.5
HP-58	Knoxville	37	1.1 ± 0.5
Average			1.4 ± 0.1

[a]Weekly averaged concentration.
[b]See Figure 1.
[c]See Figure 2.

Table 14

CHEMICAL WATER QUALITY DATA – WHITE OAK DAM
(Location W-1, Figure 3)
1979

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cr	11	<0.005	<0.005	<0.005	0.05	<10
Zn	11	<0.02	<0.02	<0.02	0.1	<20
NO_3(N)	11	4.3	0.2	2.7 ± 0.8	10	27
Hg	12	<0.001	<0.001	<0.001	0.005	<20

[a]Tennessee Stream Guidelines.

Table 15

CHEMICAL WATER QUALITY DATA – MELTON HILL DAM
(Location C-2, Figure 3)
1979

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cr	11	<0.005	<0.005	<0.005	0.05	<10
Zn	11	<0.02	<0.02	<0.02	0.1	<20
NO_3(N)	11	2.5	<0.1	<0.04 ± 0.4	10	< 4
Hg	12	<0.001	<0.001	<0.001	0.005	<20

[a]Tennessee Stream Guidelines.

Table 16

CHEMICAL WATER QUALITY DATA – ORGDP SANITARY WATER PUMPING STATION
(Location C-3, Figure 3)
1979

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	12	0.01	< 0.005	< 0.008 ± 0.002	0.05	<16
CN	12	< 0.002	< 0.002	< 0.002	0.01	<20
NO_3(N)	12	0.9	0.2	0.7 ± 0.1	10	7
Pb	12	0.01	< 0.01	< 0.01	0.05	<20
$SO_4^=$	12	24	10	17 ± 3	250	7
T.D.S.	12	178	98	144 ± 16	500	29
Zn	12	0.1	< 0.02	< 0.06 ± 0.02	0.1	<60
F^-	12	0.1	< 0.1	< 0.1	1.0	<10
Hg	12	< 0.001	< 0.001	< 0.001	0.005	<20
Ni	12	0.01	< 0.005	< 0.009 ± 0.002	0.1	< 9

[a]Tennessee Stream Guidelines.

Table 17

CHEMICAL WATER QUALITY DATA – ORGDP RECIRCULATING WATER PUMPING STATION
(Location C-4, Figure 3)
1979

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	12	0.02	< 0.005	< 0.009 ± 0.002	0.05	<18
CN	12	< 0.002	< 0.002	< 0.002	0.01	<20
$NO_3(N)$	12	5	0.2	0.9 ± 0.9	10	9
Pb	12	< 0.01	< 0.01	< 0.01	0.05	<20
$SO_4^{=}$	12	26	10	18 ± 3	250	7
T.D.S.	12	210	78	147 ± 25	500	30
Zn	12	0.2	0.04	0.1 ± 0.02	0.1	100
F^-	12	0.2	< 0.1	< 0.1 ± 0.01	1.0	<10
Hg	12	< 0.001	< 0.001	< 0.001	0.005	<20
Ni	12	0.01	< 0.005	< 0.009 ± 0.002	0.1	< 9

[a]Tennessee Stream Guidelines.

Table 18

CHEMICAL WATER QUALITY DATA – CLINCH RIVER DOWNSTREAM OF ORGDP
(Location C-6, Figure 3)
1979

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	12	0.01	< 0.005	< 0.008 ± 0.002	0.05	<16
CN	12	0.01	< 0.002	< 0.003 ± 0.002	0.01	<30
$NO_3(N)$	12	5	< 0.1	< 1 ± 0.09	10	<10
Pb	12	0.1	< 0.01	< 0.01 ± 0.001	0.05	<20
$SO_4^=$	12	25	12	18 ± 2	250	7
T.D.S.	12	196	102	141 ± 21	500	28
Zn	12	0.04	< 0.02	< 0.02 ± 0.01	0.1	<20
F^-	12	0.4	< 0.1	< 0.1 ± 0.06	1.0	<10
Hg	12	0.002	< 0.001	< 0.001 ± 0.0002	0.005	<20
Ni	12	0.01	< 0.005	< 0.009 ± 0.001	0.1	< 9

[a]Tennessee Stream Guidelines.

Table 19

CHEMICAL WATER QUALITY DATA – EAST FORK POPLAR CREEK
(Location E-1, Figure 3)
1979

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cl^-	12	17	< 2	< 11 ± 5	250	< 5
Cr	12	< 0.01	< 0.01	< 0.01	0.05	<20
F^-	12	1	0.3	0.9 ± 0.3	1.0	90
Hg	12	0.004	< 0.001	< 0.002 ± 0.001	0.005	<40
$NO_3(N)$	12	5	2	3 ± 1	10.0	30
Pb	12	< 0.01	< 0.01	< 0.01	0.05	<20
$SO_4^=$	12	73	< 10	< 46 ± 15	250	<19
T.D.S.	12	250	150	200 ± 30	500	40
Zn	12	0.8	< 0.02	< 0.04 ± 0.02	0.1	<40

[a]Tennessee Stream Guidelines.

Table 20

CHEMICAL WATER QUALITY DATA – BEAR CREEK
(Location B-1, Figure 3)
1979

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	0.007	< 0.005	< 0.005 ± 0.001	0.01	< 50
Cl^-	12	9	< 2	< 5 ± 2	250	< 2
F^-	12	0.3	< 0.1	< 0.2 ± 0.1	1.0	< 20
NO_3(N)	12	23	5	13 ± 5	10	130
$SO_4^=$	12	14	<10	<11 ± 1	250	< 5
Zn	12	0.1	< 0.02	< 0.03 ± 0.03	0.1	< 30

[a]Tennessee Stream Guidelines.

Table 21

CHEMICAL WATER QUALITY DATA – POPLAR CREEK ABOVE BLAIR BRIDGE
(Location P-1, Figure 3)
1979

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	12	0.01	< 0.005	< 0.008 ± 0.002	0.05	<16
CN	12	0.005	< 0.002	< 0.002 ± 0.0006	0.01	<20
NO_3(N)	12	10	0.7	2 ± 2	10	20
Pb	12	< 0.01	< 0.01	< 0.01	0.05	<20
$SO_4^{=}$	12	45	24	31 ± 4	250	12
T.D.S.	12	333	49	185 ± 50	500	37
Zn	12	0.2	< 0.02	< 0.06 ± 0.04	0.1	<60
F^-	12	0.2	0.1	0.1 ± 0.03	1.0	10
Hg	12	0.008	< 0.001	< 0.002 ± 0.001	0.005	<40
Ni	12	0.02	< 0.005	< 0.01 ± 0.002	0.1	<10

[a]Tennessee Stream Guidelines.

Table 22

CHEMICAL WATER QUALITY DATA – POPLAR CREEK NEAR CLINCH RIVER
(Location P-2, Figure 3)
1979

SUBSTANCE	NUMBER OF SAMPLES	CONCENTRATION, mg/l				% STD.
		MAXIMUM	MINIMUM	AVERAGE	STD.[a]	
Cd	12	< 0.005	< 0.005	< 0.005	0.01	<50
Cr	12	0.01	< 0.005	< 0.007 ± 0.002	0.05	<15
CN	12	0.005	< 0.002	< 0.002 ± 0.0006	0.01	<20
$NO_3(N)$	12	1	< 0.1	< 0.7 ± 0.2	10	< 7
Pb	12	< 0.01	< 0.01	< 0.01	0.05	<20
$SO_4^=$	12	33	19	27 ± 3	250	11
T.D.S.	12	266	81	156 ± 31	500	31
Zn	12	0.3	< 0.02	< 0.08 ± 0.05	0.1	<80
F^-	12	0.2	< 0.1	< 0.1 ± 0.03	1.0	<10
Hg	12	< 0.001	< 0.001	< 0.001	0.005	<20
Ni	12	0.03	0.006	0.01 ± 0.004	0.1	10

[a]Tennessee Stream Guidelines.

Table 23

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) EXPERIENCE 1979

DISCHARGE POINT	EFFLUENT PARAMETERS	EFFLUENT LIMITS DAILY AVERAGE mg/l	EFFLUENT LIMITS DAILY MAXIMUM mg/l	PERCENTAGE OF MEASUREMENTS IN COMPLIANCE
ORNL				
001				
(White Oak Creek)	Dissolved Oxygen (min.)	5	— —	100
	Dissolved Solids	— —	2000	100
	Oil and Grease	10	15	89
	Chromium (Total)	— —	0.05	100
	pH (pH units)	— —	6.0—9.0	100
002				
(Melton Branch)	Chromium (total)	— —	0.05	100
	Dissolved Solids	— —	2000	100
	Oil and Grease	10	15	100
	pH(pH units)	— —	6.0—9.0	100
003				
(Main Sanitary	Ammonia (N)	— —	5	56
Treatment Facility)	BOD	— —	20	85
	Chlorine Residual	— —	0.5—2.0	99
	Fecal Coliform Bact. (No/100 ml)	200[b]	400[c]	100
	pH (pH units)	— —	6.0—9.0	100
	Suspended Solids	— —	30	92
	Settleable Solids (ml/l)	— —	0.5	94
004				
(7900 Area Sanitary	BOD	— —	30	No Discharges
Treatment Facility)	Chlorine Residual	— —	0.5—2.0	From This
	Fecal Coliform Bact. (No/100 ml)	200[b]	400[c]	Facility
	pH (pH units)	—	6.0—9.0	
	Suspended Solids	—	30	
	Settleable Solids (ml/l)	—	0.5	
Y-12 PLANT				
001				
(Kerr Hollow	Dissolved Solids	— —	2000	100
Quarry)	Lithium	— —	5	100
	pH (pH units)	— —	6.0—9.0	100
	Suspended Solids	— —	50	100
	Zirconium	— —	3	No Disposals
002				
(Rogers Quarry)	pH (pH units)	— —	6.0—9.0	100
	Suspended Solids[a]	30	50	100
	Settleable Solids (ml/l)[(a)]	— —	0.5	100

Table 23
(CONTINUED)

DISCHARGE POINT	EFFLUENT PARAMETERS	EFFLUENT LIMITS DAILY AVERAGE mg/l	EFFLUENT LIMITS DAILY MAXIMUM mg/l	PERCENTAGE OF MEASUREMENTS IN COMPLIANCE
003 (New Hope Pond)	Ammonia (N)	--	1.6	100
	Chromium	0.05	0.08	100
	Dissolved oxygen (Min.)	5	--	100
	Dissolved Solids	--	2000	100
	Fluoride	1.5	2.0	92
	Lithium	--	5	100
	Oil and Grease	10	15	100
	pH (pH units)	--	6.0—9.0	100
	Phosphate (as MBAS)	5	8	100
	Suspended Solids[a]	--	20	100
	Settleable Solids (ml/l)[a]	--	0.5	100
	Total Nitrogen (N)	--	20	100
	Zinc	0.1	0.2	99
004 (Bear Creek)	Oil and Grease	10	15	100
	pH (pH units)	--	6.0—8.5	100
ORGDP				
001 (K-1700 Discharge)	Aluminum	--	1.0	100
	Chromium (Total)	0.05	0.08	100
	Nitrate	--	20	100
	Suspended Solids	30	50	100
	Oil and Grease	10	15	100
	pH (pH units)	--	6.0—9.0	99
002 (K-1410 Metal Plating Facility)	Cyanide	--	None Detectable	100
	Oil and Grease	10	15	100
	pH (pH units)	--	6.0—9.0	100
004 (K-1131 Steam Condensate Discharge)	pH (pH units)	--	6.0—9.0	100
	Flow (MGD)	0.005	0.008	100
005 (K-1203 Sanitary Treatment Facility)	Ammonia (N)	5[b]	7[c]	100
	BOD	15[b]	20[c]	93
	Chlorine Residual	--	0.5—2.0	100
	Dissolved Oxygen (Min.)	5	--	100
	Fecal Coliform Bact. (No/100 ml)	200[b]	400[c]	100
	pH (pH units)	--	6.0—9.0	100
	Suspended Solids	30[b]	45[c]	86
	Settleable Solids (ml/l)	--	0.5	86

Table 23
(CONTINUED)

DISCHARGE POINT	EFFLUENT PARAMETERS	EFFLUENT LIMITS DAILY AVERAGE mg/l	EFFLUENT LIMITS DAILY MAXIMUM mg/l	PERCENTAGE OF MEASUREMENTS IN COMPLIANCE
006				
(K-1007B Holding	COD	20	25	98
Pond)	Chromium	— —	0.05	100
	Dissolved Oxygen (Min.)	5	— —	100
	Fluoride	1.0	1.5	100
	Oil and Grease	10	15	100
	pH (pH units)	— —	6.0—9.0	99
	Suspended Solids[a]	30	50	100
007				
(K-901A Holding	Chromium (total)	— —	0.05	85
Pond)	Fluoride	1.0	1.5	100
	Oil and Grease	10	15	100
	pH (pH units)	— —	6.0—10	100
	Suspended Solids	30	50	100
008[d]				
(K-710 Sanitary	BOD	30[b]	45[c]	No Discharges
Treatment Facility)	Suspended Solids	30[b]	45[c]	From This
	Fecal Coliform Bact. (No/100 ml)	200[b]	400[c]	Facility
	pH (pH units)	— —	6.0—9.0	
	Chlorine Residual	— —	0.5—2.0	
	Settleable Solids (ml/l)	— —	0.1	
009	Suspended Solids[a]	30	50	100
(Sanitary Water	Aluminum	— —	250	100
Plant)	Sulphate	— —	1400	100
	pH (pH units)	— —	6.0—9.0	100

[a]Limit applicable only during normal operations. Not applicable during periods of increased discharge due to surface run-off resulting from precipitation.

[b]Monthly Average.

[c]Weekly Average.

[d]Due to the small flow rates at the K-710 Sanitary Treatment Facility, a rapid sand filter was installed May 1, 1978 eliminating the surface discharge and monitoring requirements.

Table 24
CONCENTRATION OF ^{131}I IN MILK[a]
1979

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF 10^{-9} μCi/ml			COMPARISON WITH STANDARD[c]
		MAXIMUM	MINIMUM[b]	AVERAGE	
		Immediate Environs[d]			
1	45	0.45	<0.45	<0.45	Range I
2	48	1.20	<0.45	<0.47 ± 0.03	Range I
3	46	0.45	<0.45	<0.45	Range I
4	45	0.45	<0.45	<0.45	Range I
5	48	8.00	<0.45	<0.61 ± 0.31	Range I
6	46	1.40	<0.45	<0.50 ± 0.05	Range I
7	46	7.00	<0.45	<0.60 ± 0.28	Range I
8	45	8.00	<0.45	<0.61 ± 0.30	Range I
Average				<0.52 ± 0.06	
		Remote Environs[e]			
51	8	<0.45	<0.45	<0.45	Range I
52	8	<0.45	<0.45	<0.45	Range I
53	7	<0.45	<0.45	<0.45	Range I
56	3	<0.45	<0.45	<0.45	Range I
57	10	<0.45	<0.45	<0.45	Range I
58	8	<0.45	<0.45	<0.45	Range I
Average				<0.45	

[a]Raw milk samples, except for station 2 which is a dairy.

[b]Minimum detectable concentration of ^{131}I is 0.45 x 10^{-9} μCi/ml.

[c]Applicable FRC standard, assuming 1 liter per day intake:

Range I	0 to 1 x 10^{-8} μCi/ml	- Adequate surveillance required to confirm calculated intakes.
Range II	1 x 10^{-8} μCi/ml to 1 x 10^{-7} μCi/ml	- Active surveillance required.
Range III	1 x 10^{-7} μCi/ml to 1 x 10^{-6} μCi/ml	- Positive control action required.

Note: Upper limit of Range II can be considered the concentration guide.

[d]See Figure 6.

[e]See Figure 7.

Table 25
CONCENTRATION OF ^{90}Sr IN MILK[a]
1979

STATION NUMBER	NUMBER OF SAMPLES	UNITS OF 10^{-9} μCi/ml			COMPARISON WITH STANDARD[c]
		MAXIMUM	MINIMUM[b]	AVERAGE	
		Immediate Environs[d]			
1	41	3.7	0.9	2.6 ± 0.2	Range I
2	46	3.0	0.7	1.8 ± 0.1	Range I
3	44	3.4	0.7	1.7 ± 0.2	Range I
4	40	3.1	0.9	1.9 ± 0.2	Range I
5	45	4.1	0.7	2.1 ± 0.2	Range I
6	45	8.9	1.8	4.3 ± 0.5	Range I
7	44	4.1	0.9	2.2 ± 0.2	Range I
8	43	4.0	1.2	3.1 ± 0.3	Range I
Average				2.5 ± 0.1	
		Remote Environs[e]			
51	8	3.4	1.4	2.8 ± 0.5	Range I
52	7	2.3	0.9	1.5 ± 0.5	Range I
53	7	2.1	0.9	1.3 ± 0.3	Range I
56	3	1.8	1.4	1.6 ± 0.3	Range I
57	10	4.1	1.6	2.6 ± 0.5	Range I
58	8	1.8	0.9	1.4 ± 0.2	Range I
Average				1.9 ± 0.5	

[a]Raw milk samples, except for station 2 which is a dairy.

[b]Minimum detectable concentration of ^{90}Sr in milk is 0.5×10^{-9} μCi/ml.

[c]Applicable FRC Standard, assuming 1 liter per day intake:

Range I	0 to 2×10^{-8} μCi/ml	- Adequate surveillance required to confirm calculated intakes.
Range II	2×10^{-8} μCi/ml to 2×10^{-7} μCi/ml	- Active surveillance required.
Range III	2×10^{-7} μCi/ml to 2×10^{-6} μCi/ml	- Positive control action required.

Note: Upper limit of Range II can be considered the concentration guide.

[d]See Figure 6.

[e]See Figure 7.

Table 26

RADIONUCLIDE CONTENT IN CLINCH RIVER FISH

1979

pCi/kg-Wet Weight

LOCATION	Species[a]	^{90}Sr	^{239}Pu	^{238}Pu	^{238}U	^{235}U	^{234}U	^{137}Cs	^{60}Co	^{40}K	% MPI[b]	Hg (ng/g)	% of A.L.[c]
CRM 5.0	Bass	2	0.03	0.02	0.4	0.03	0.5	151	6	327	0.03	2.6	0.5
	Blue Gill	7	0.05	0.02	0.7	0.16	1.2	77	4	4137	0.05	3.1	0.6
	Carp	5	0.01	0.02	0.6	0.08	0.8	59	3	3525	0.04	5.6	1.1
	Shad	9	0.05	0.02	6.2	0.34	9.2	66	5	2508	0.07	0.7	0.1
	Crappie	5	0.02	0.02	0.4	0.04	0.8	56	4	2819	0.11	2.0	0.4
CRM 12.0	Bass	9	0.06	0.03	1.2	0.23	2.3	1649	13	16177	0.21	5.2	1.0
	Blue Gill	1	0.88	0.88	9.4	2.31	11.7	120	15	12876	0.16	5.9	1.2
	Carp	18	0.23	0.17	8.1	0.68	13.0	406	16	18976	0.17	20.0	4.0
	Shad	47	0.26	0.03	104	0.79	135	416	20	7288	0.38	1.7	0.3
	Crappie	14	0.03	0.10	1.3	8.50	3.1	683	14	18089	0.17	4.2	0.8
CRM 20.8[d]	Bass	11	0.01	0.01	0.2	0.06	0.4	1252	9	3275	0.14	1.5	0.3
	Blue Gill	255	0.03	0.08	0.7	0.09	1.3	3955	92	3159	2.20	3.7	0.7
	Carp	57	0.02	0.03	0.3	0.08	0.6	502	17	3314	0.45	2.6	0.5
	Shad	23	0.06	0.09	2.1	0.27	3.3	513	82	2668	0.23	0.5	0.1
	Crappie	14	0.01	0.15	0.7	0.09	1.9	393	11	4021	0.14	3.2	0.6
CRM 25.0	Bass	7	0.04	0.08	1.2	0.23	1.7	219	12	23870	0.07	1.2	0.2
	Blue Gill	7	0.07	0.70	1.9	1.40	5.2	153	21	20126	0.07	0.7	0.1
	Carp	4	0.08	0.08	1.1	0.56	1.8	29	18	13875	0.03	1.4	0.3
	Shad	7	0.07	0.07	2.4	0.33	3.3	32	7	10528	0.07	0.2	0.1

[a]Composite of 10 fish in each species.

[b]Maximum Permissible Intake-Intake of radionuclide from eating fish is calculated to be equal to a daily intake of 2.2 liters of water over a period of one year, containing the concentration guide of radionuclides in question. Consumption of fish is assumed to be 16.8 kg/yr of the species in question. Only man-made radionuclides were used in the calculation.

[c]Percent of proposed FDA Mercury in fish action level of 500 ng/g; Mercury data included in this table as a matter of convenience.

[d]Average of quarterly samples.

Table 27
^{137}Cs CONCENTRATION IN DEER SAMPLES
1979
pCi/kg Wet Weight

LOCATION	NUMBER OF SAMPLES	MAXIMUM	MINIMUM	AVERAGE
On Site	20	589	24	99
Off Site	3	548	95	264

Table 28
VEGETATION SAMPLING DATA
1979

STATION NUMBER[a]	F^- CONCENTRATION[b] µg/g (ppm)		U (TOTAL) CONCENTRATION[b] µg/g (ppm)	
	GRASS	PINE NEEDLES	GRASS	PINE NEEDLES
1	8	--	0.1	--
2	7	5	0.1	0.06
3	7	9	0.1	0.05
4	8	10	0.1	0.1
5	10	12	0.1	0.2
6	9	10	0.08	0.09
7	11	8	0.1	0.1
8	12	14	0.2	0.3
9	12	7	0.2	0.09
10	12	13	0.1	0.1
11	18	14	0.7	0.5
12	14	11	0.2	0.2
13	11	--	0.1	--
14	9	--	0.04	--
15	11	--	0.04	--
16	8	--	0.1	--
17	11	--	0.4	--

[a]See Figure 1.

[b]Average concentration of two sample collections, January and July. Analytical results are on a dry weight basis.

NOTE: Applicable guides for flora have not been established. However, for comparison the *American Industrial Hygiene Association Journal* for January-February 1969 (pp. 98-101) states that dairy cattle is the species of livestock most sensitive to fluorides in grasses. For comparative purposes the following fluoride concentrations and their effect on dairy cattle are given.

30 ppm	-	no adverse effects
30 to 40 ppm	-	borderline chronic
40 to 60 ppm	-	moderate chronic
60 to 110 ppm	-	severe chronic
above 250 ppm	-	acute

Table 29

RADIOACTIVITY IN GRASS SAMPLES FROM PERIMETER AND REMOTE MONITORING STATIONS
1979
(Units of pCi/g-Dry Weight)

SAMPLING LOCATION[a]	^{7}Be	^{90}Sr	^{137}Cs	^{239}Pu	^{238}Pu	^{238}U	^{235}U	^{234}U
				Perimeter				
HP-31	13	.6	.2	.002	.001	.04	.010	.08
HP-32	10	.6	ND	.010	.010	.01	.010	.36
HP-33	10	.5	ND	.001	.001	.02	.004	.03
HP-34	8	.6	.3	.001	.001	.03	.004	.03
HP-35	4	.1	.1	.002	.002	.03	.001	.04
HP-36	10	.6	.1	.003	.003	.03	.004	.05
HP-37	10	.4	ND	.001	.003	.02	.002	.03
HP-38	6	.3	ND	.004	.004	.03	.004	.04
HP-39	19	.5	.2	.002	.001	.04	.002	.04
Average	11	.5	.1	.003	.003	.03	.005	.03
				Remote				
HP-51	14	.6	.1	.001	.0014	.08	.008	.09
HP-52	14	.1	.1	.001	.0022	.02	.004	.01
HP-53	13	.3	.1	.001	.0005	.09	.010	.10
HP-54	12	.4	.1	.001	.0003	.01	.003	.01
HP-55	12	.4	.2	.002	.0005	.06	.006	.08
HP-56	20	.2	.3	.002	.0003	.02	.005	.03
HP-57	26	.3	.1	.002	.0005	.03	.005	.05
HP-58	16	.4	.1	.001	.0003	.04	.004	.06
Average	16	.3	.1	.001	.0008	.04	.010	.05

[a]See Figures 1 and 2.

Table 30

RADIOACTIVITY IN SOIL SAMPLES FROM PERIMETER AND REMOTE MONITORING STATIONS
1979
(Units of pCi/g-Dry Weight)

SAMPLING LOCATION[a]	^{90}Sr	^{137}Cs	^{226}Ra	^{234}U	^{235}U	^{238}U	^{238}Pu	^{239}Pu
				Perimeter[b]				
HP-31	.3	1.0	1.5	0.4	.01	.23	.003	.02
HP-32	.3	1.5	0.9	1.4	.05	.86	.002	.02
HP-33	.4	1.8	0.9	0.3	.02	.21	.001	.01
HP-34	.5	2.6	0.9	0.3	.01	.21	.001	.06
HP-35	.1	2.0	1.2	0.5	.03	.37	.001	.04
HP-36	.2	1.8	1.1	0.4	.02	.31	.001	.03
HP-37	.2	0.7	0.7	0.4	.02	.27	.010	.01
HP-38	.3	1.4	0.6	0.3	.01	.24	.003	.02
HP-39	.4	2.4	1.1	1.1	.03	.90	.002	.03
Average	.4	1.5	1.0	0.6	.02	.38	.003	.03
				Remote[c]				
HP-51	.12	0.9	1.0	.30	.01	.25	.002	.01
HP-52	.38	1.7	1.4	.62	.02	.49	.001	.02
HP-53	.30	1.5	2.1	.89	.04	.76	.001	.04
HP-54	.17	2.8	1.5	.57	.02	.54	.001	.05
HP-55	.43	1.5	1.1	.43	.03	.32	.002	.02
HP-56	.21	1.6	1.1	.32	.02	.26	.002	.03
HP-57	.20	2.3	1.4	.62	.02	.49	.001	.04
HP-58	.24	1.4	1.0	.38	.02	.30	.001	.02
Average	.29	1.7	1.3	.52	.02	.43	.001	.03

[a]See Figures 1 and 2.

[b]Average of two samples.

[c]One sample

Table 31

STREAM SEDIMENT SAMPLES
July/November 1979
Average Concentration (μg/g dry weight basis)

STATION	U	Hg[a]	Pb	Ni	Cu	Zn	Cr	Mn	Cd	Al	Th
CS1	2	< 0.2	33	30	15	48	25	985	<5	26000	<40
PS2	17	35	63	135	110	163	219	600	<5	93000	<40
PS5	5	< 0.3	48	88	31	103	60	360	<5	60000	<40
PS6	14	11	54	147	45	172	224	525	<5	52500	<40
PS9	6	3	40	61	92	82	50	570	<5	34500	<40
PS10	4	3	40	79	29	84	77	810	<5	34000	<40
PS12	17	< 9	44	75	34	104	98	813	<5	43500	<40
PS15	14	6	43	109	39	97	62	523	<5	39500	<40
PS17	181	<13	76	790	412	237	97	570	<5	52000	<40
PS18	6	4	48	103	38	84	59	496	<5	36500	<40
PS19	17	21	54	120	43	95	88	422	<5	29000	<40
PS21	7	< 1	68	110	81	124	101	543	<5	73000	<40
PS22	12	7	65	157	44	103	88	513	<5	34000	<40
CS20	1	< 0.2	37	26	65	47	244	386	<5	26500	<40

[a]Average of two samples, some results were below detectable limit.

Table 32

SUMMARY OF THE ESTIMATED RADIATION DOSE
TO AN ADULT INDIVIDUAL DURING 1979 AT LOCATIONS OF MAXIMUM EXPOSURE

PATHWAY	LOCATION	DOSE (MILLIREM) TOTAL BODY	DOSE (MILLIREM) CRITICAL ORGAN
Gaseous Effluents			
All pathways	Nearest resident	0.5[a]	5.1 (lung)[a]
Terrestrial food chains to milk	Milk sampling station number 6 (^{90}Sr)	0.2	7.3 (bone)
Liquid Effluents			
Aquatic food chains to fish	Clinch River (^{90}Sr)	0.7	35 (bone)
Drinking water[b]	Kingston, Tennessee (^{90}Sr)	0.05	2.3 (bone)
Direct radiation along water, shores, and mud flats.[c]	In Clinch River, downstream from White Oak Creek near experimental Cs field plots	6.6	6.6 (total body)

[a]Uncertainties in these calculated doses may be as much as 300% (see text).

[b]Based on the analysis of raw (unprocessed) water; see text.

[c]Assuming a residence time of 240 hr/yr.

NOTE: Average background total body dose in the U.S., [30] is 106 mrem/yr.

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APPENDIX A
QUALITY ASSURANCE

Radiological

The Environmental Surveillance and Evaluation Section at Oak Ridge National Laboratory has initiated a quality assurance program to ensure that a high degree of accuracy and reliability is maintained in its surveillance activities. The program in effect at ORNL consists of quality control of techniques and procedures, and includes the establishment of a detailed written description of all activities pertaining to the Environmental Surveillance and Evaluation Section. This includes:

1. Operating procedures for each activity.
2. Inspection lists of operating and maintenance activities.
3. Check-off frequency lists for all quality assurance steps, such as schedules for equipment inspection and test control.
4. Documentation of compliance of quality assurance procedures.
5. Participation in intralaboratory and interlaboratory sample-exchange programs.
6. Evaluation of the adequacy of sample preparation work and data analysis.
7. Identification of the role, responsibilities, and authority of each staff member as related to quality assurance.

A schematic diagram showing a flow chart of this quality assurance program is given in Figure A1. A more detailed discussion of the ORNL QA program is given in Ref. (A1) and (A2).

Chemical

A Nuclear Division Committee on Environmental Analysis established an interlaboratory quality control program in 1977. The purpose of this program is to provide quality control data for environmental analysis within the Nuclear Division. A unified Environmental and Effluent Analysis Manual was issued in March of 1977 which currently contains 78 analytical procedures; EPA-certified analytical methods are used wherever possible.

All Nuclear Division analytical laboratories maintain internal measurement control programs that are part of planned and systematic actions taken to prevent incorrect results. Standard samples containing all parameters measured are purchased and submitted to the laboratories for analysis. Standard samples of known values are processed along with routine samples and the results are recorded and examined to determine if they fall within prescribed limits. Analytical results are transmitted to the Y-12 Plant Quality Control Department for statistical review and a semi-annual report is provided to the analytical laboratories.

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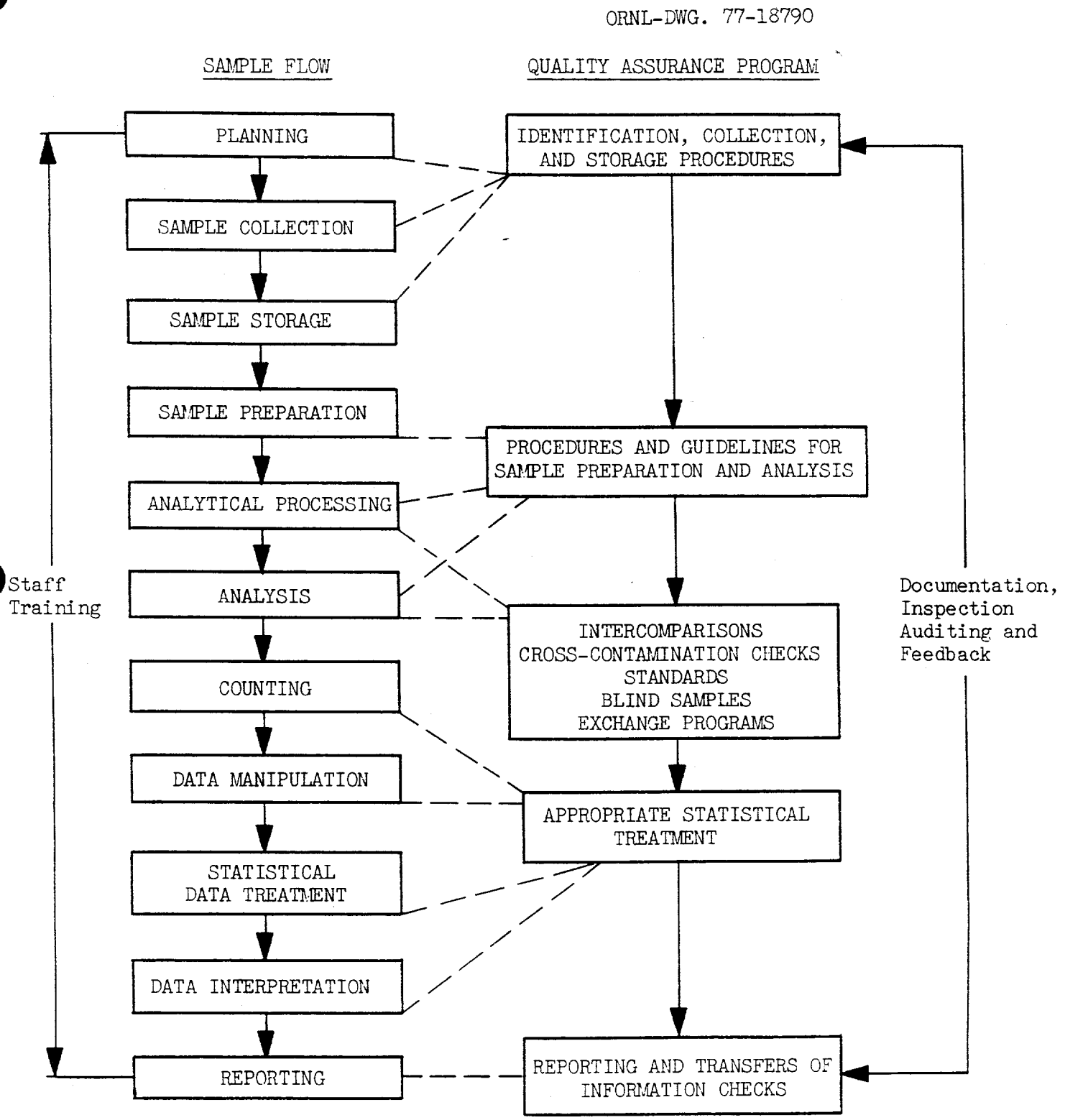

Figure A1
FLOW CHART OF QA PROGRAM

EXTERNAL DISTRIBUTION

Director, Division of Industrial and Radiological Health,
Tennessee State Health Department
Director, Tennessee State Health Department
Federal Activities Coordinator, EPA Region IV
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